



United Nations  
Educational, Scientific and  
Cultural Organization



Mahatma Gandhi Institute  
of Education for Peace  
and Sustainable Development

# TEXTBOOKS FOR SUSTAINABLE DEVELOPMENT

## A GUIDE TO EMBEDDING



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Mahatma Gandhi Institute  
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# Foreword

**THE IMPORTANCE OF TEXTBOOKS IS INDISPUTABLE.** States and civil society organisations use them to define which knowledge to pass on to the next generation and which competencies to foster. Textbooks often become a political issue because they reflect a society's educational canon and the constant negotiation processes that shape it. At the same time, through their selection of content and pedagogy, textbooks can contribute significantly to peace education, human rights education, global citizenship education and education for sustainable development (ESD) by endowing young people with the ability to arrive at independent opinions free of prejudice.

This valuable and timely guidebook represents an innovative contribution to enhancing quality education through textbooks. It will change the way textbook authors, publishers and educators, as well as governments of the United Nations Member States, see the potential of educational media at a time of growing violent extremism, changing notions of national identity, increasingly globalized and diverse communities, and environmental destruction. The need for education that promotes peace, social justice and global citizenship has become more urgent in a world of greater uncertainty. This guidebook builds on the momentum of Agenda 2030, providing a toolkit to enable textbook authors to place ESD at the core of their subjects in ways that are at once practical for them and interesting and relevant to the students. In fact, it demonstrates successfully how ESD has become an important indicator of educational quality. After reading this publication, I was deeply impressed by the myriad ways in which subjects such as mathematics can play just as important a role as science and geography in promoting sustainable development, peace and global citizenship. This publication reminds us that it is high time to rethink all subject areas, given the interconnected challenges facing our planet.

*This guidebook builds on the momentum of Agenda 2030, providing a toolkit to enable textbook authors to place ESD at the core of their subjects in ways that are at once practical for them and interesting and relevant to the students*

The guidebook is also an apt reminder of the ways in which education for peace and global citizenship are inextricably linked both to each other and to sustainable development. Global citizenship education, for example, emphasizes belonging to a common humanity and strengthening the concept of solidarity, not just within one's immediate community but also on a global scale. This, in turn, demands awareness that global issues require global solutions and cooperation, and a desire to work proactively with others for a peaceful and sustainable future. Yet long-term peace can only be achieved in a society that respects different cultures and their human rights, promotes social justice and maintains economic viability for present and future generations. Peace requires learning to share limited resources equitably and express disagreement through democratic engagement rather than resorting to violent extremism.

UNESCO and the Georg Eckert Institute (GEI) share a long history of joint commitment to textbook revision, beginning when Georg Eckert and UNESCO cooperated to support reconciliation between former enemy countries after the Second World War. Since then, the improvement of textbook quality has remained a central pillar of our collaboration. The GEI and UNESCO have published several important handbooks and expert studies, among them *The UNESCO Guidebook on Textbook Research and Textbook Revision* (1999/2010), a study entitled *The International Status of Education About the Holocaust* (2014) and most recently the *Toolkit on Revision/Adaptation of Curricula, School Textbooks and Other Learning Materials to Remove Cultural, Religious and Gender-Biased Stereotypes* (2017). Over the coming years, this cooperation with UNESCO and its institutions, including the Mahatma Gandhi Institute of Education for Peace and Sustainable Development, will continue to play a vital role in the GEI's efforts to advance a culture of peace in the educational arena.

I am convinced that this guidebook will be an eye-opener for many stakeholders in curriculum and textbook development. It will help foster a reflective ethos and a sense of responsibility for a common humanity, empowering students to become critical thinkers, empathetic citizens and active agents of their communities.



**Eckhardt Fuchs**

Director

Georg Eckert Institute for International Textbook Research



# Director's message

**THE WORLD HAS SET AN AMBITIOUS** 2030 Agenda for Sustainable Development, with Goal 4 of the Sustainable Development Goals focusing on quality education – 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'.

The United Nations Decade of Education for Sustainable Development (2005–2014) marked a positive beginning in reorienting and transforming education towards sustainable development. However, many educational efforts to achieve a better future for all remain isolated and marginalized. Barring creative initiatives in various parts of the world, value-based and action-oriented education efforts have tended to focus on standalone subjects that normally fall on the fringes of the curriculum. Education for sustainable development, global citizenship education, peace education, human rights education, environmental education, development education, global education and global learning, among many others, have largely been promoted as 'add-ons' by celebrating events such as Earth Day or the International Day of Peace. Often they needlessly compete for space in an already overcrowded curriculum.

Not much systematic work has been done to bring together the community of scholars and practitioners, who focus on value-based and purpose-driven education, with experts in the design of curriculum 'core subjects' to develop a curricular framework that looks at sustainable development as integral to all subjects. The few exceptions include pioneering efforts at the national level by the German government as a joint project of the KMK (Standing Conference of the German Ministers of Education and Culture) and the BMZ (German Federal Ministry for Economic Cooperation and Development)<sup>1</sup> and Finland's new National Core Curriculum.<sup>2</sup>

This guidebook introduces the approach of embedding education for sustainable development into core subjects, building on the German initiative as well as consolidating other existing efforts. This ambitious work began when the UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP), with support from Engagement Global gGmbH, brought together 30 international experts in mathematics, sciences, languages, geography and education for sustainable development in Bangalore, India, in June 2016. These experts co-drafted this guidebook.

This publication is designed as a guide for stakeholders in textbook development – education ministries, national curriculum authorities, textbook writers and publishers – to help them produce a new generation of textbooks. Such textbooks will make a clear departure from the mechanistic transmission of information and procedural knowledge devoid of meaning and contextual relevance. They will also advocate a new vision of learning and contribute to fostering young people's competencies and capabilities to shape more peaceful and sustainable societies. Competencies such as critical and systemic thinking, appreciation of diversity, empathy and commitment to change are the key goals of this ambitious publication.

As the next step, MGIEP will organize a series of national and regional training workshops for textbook authors using this guidebook in different parts of the world. Our goal is to develop the capacities of the stakeholders in textbook development the world over to produce a new generation of textbooks suited to the 21st century. This first edition includes four subjects and there are plans for the next edition to include more subject areas and to update the mathematics, science, geography and language chapters based on the feedback we receive from diverse stakeholders. We also expect to deal more extensively with the concept of the 'whole-school approach' than has been possible in this book. We shall establish an online portal, which will enable textbook authors to keep us informed about how well this guidebook is meeting their needs and where it can be enhanced, updated and expanded to serve as a living source of inspiration and guidance.

Despite years of advocacy and research on teaching and learning for a better future, education today is not fully meeting the challenge of producing citizens motivated and prepared to address the urgent problems facing humanity. With the publication of this guidebook, we hope to facilitate the process of transforming the education system from within. The concept of embedding presented in this publication is guided by a vision of a society whose citizens and professionals value mathematics, sciences, social sciences and humanities for their critical role in achieving human flourishing and the common good. Vital to realizing such a society are teachers and learners at all levels, who are engaged in, motivated by and able to work together effectively on the complex, interconnected issues that require mobilization of all disciplines.

I hope that this guidebook will provide valuable insights and support to help textbook authors identify curriculum opportunities for embedding education for sustainable development into subject content.



**Anantha Kumar Duraiah**

Director, UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development

<sup>1</sup> Schreiber, J-R and Siege, H (eds.) (2016) *Curriculum Framework Education for Sustainable Development*, Bonn: KMK and BMZ.

Available at [http://www.globaleslernen.de/sites/default/files/files/link-elements/curriculum\\_framework\\_education\\_for\\_sustainable\\_development\\_barrierefrei.pdf](http://www.globaleslernen.de/sites/default/files/files/link-elements/curriculum_framework_education_for_sustainable_development_barrierefrei.pdf)

<sup>2</sup> Halinen, I (2017) 'The conceptualization of competencies related to sustainable development and sustainable lifestyles', *In-Progress Reflection No. 8 on Current and Critical Issues in Curriculum, Learning and Assessment*, Geneva: IBE. Available at <http://unesdoc.unesco.org/images/0024/002473/247343E.pdf>

*This publication is designed as a guide for stakeholders in textbook development – education ministries, national curriculum authorities, textbook writers and publishers – to help them produce a new generation of textbooks*

## How this guidebook was developed

After the initial project conceptualization and design, we began by conducting basic research into the existing initiatives for embedding ESD, peace and global citizenship in textbooks around the world. Experts working at the interface of the core subjects (maths, science, language and geography) and sustainable development, peace and global citizenship were identified. Twenty-nine experts from around the world met at a workshop in Bangalore, India, in June 2016. They discussed the basic concept and developed the initial rudimentary ideas and structure of this guidebook. Five to six experts from each of the subject groups took on the role of contributing authors and chose a coordinating lead author (CLA) to oversee the writing of each subject chapter.

Over the next nine months, the chapters went through a series of drafts. These were discussed and deliberated over, on numerous video conferences across time zones, within each subject group and with the editorial board. The final drafts of each chapter went through a blind peer review process, involving at least four reviewers, before making it into this guidebook.

Our aim now is to train textbook writers around the world on the embedding approach, using this guidebook as a tool. The names of the contributing authors and CLAs are mentioned below, along with their email addresses. Please feel free to contact them if you have any queries about the subject chapters and guidebook. For any queries regarding the project, please contact the project management staff.

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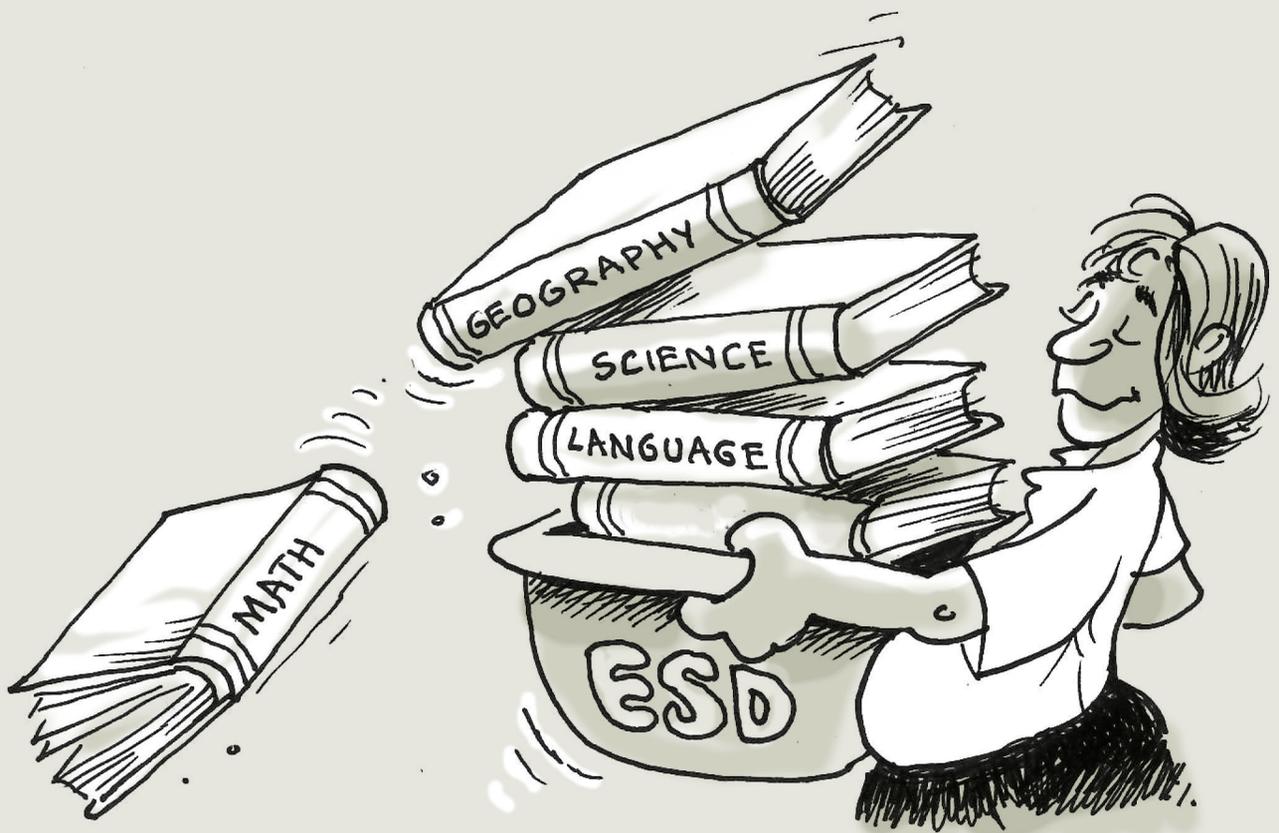
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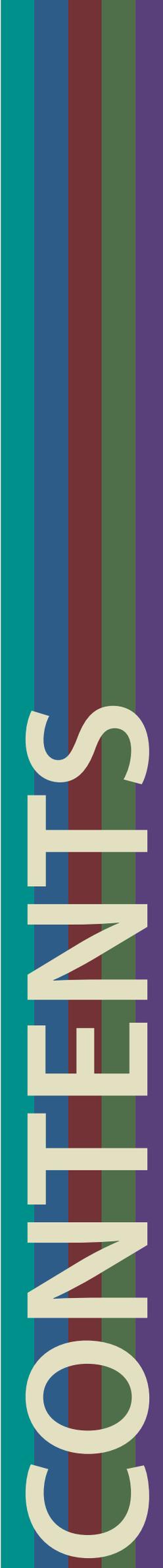
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*(Considering the participatory and collaborative nature of the project, all authors are listed in alphabetical order according to their first names.)*

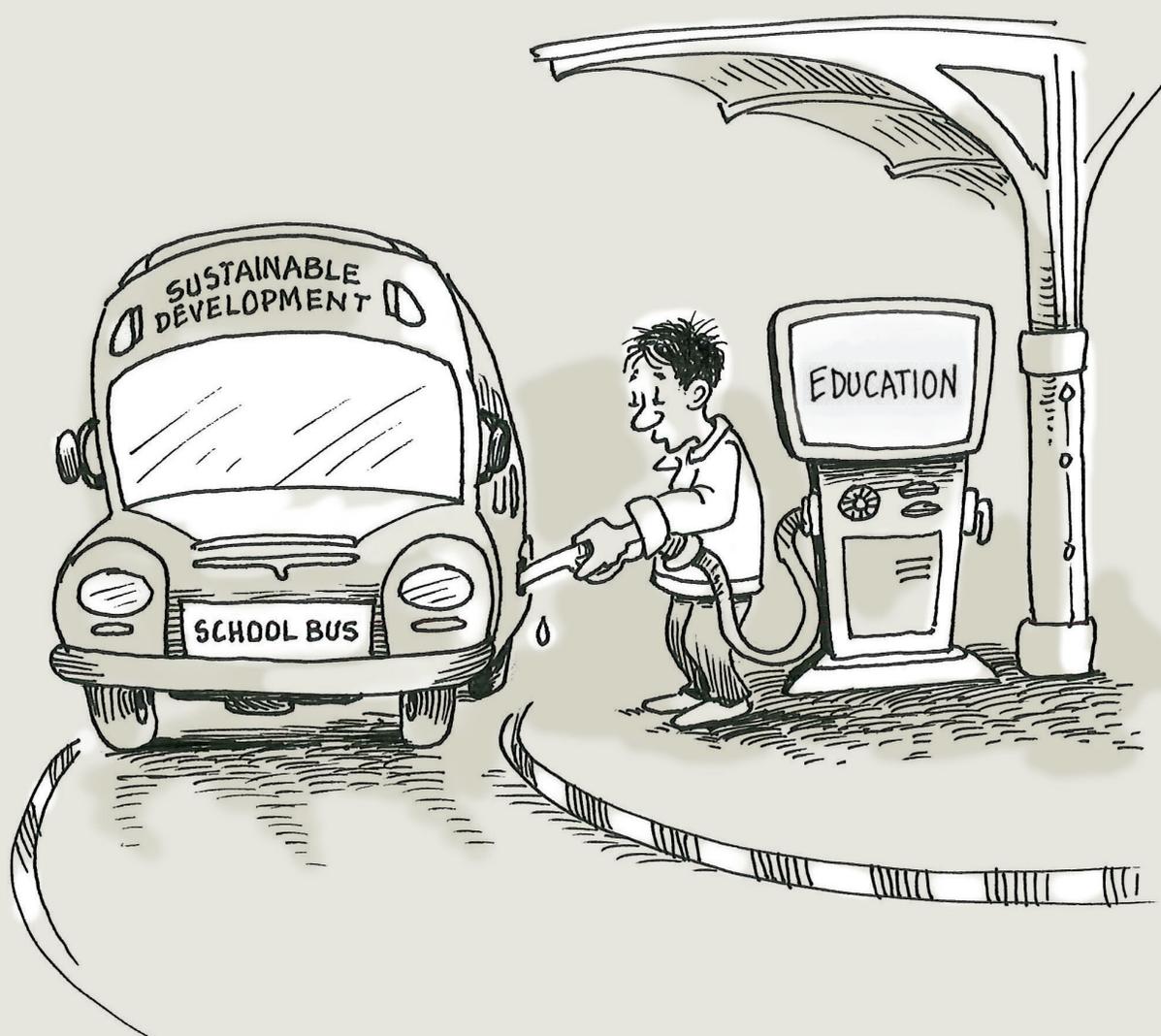


<b>Introduction</b>	11
<b>Mathematics</b>	35
<b>Science</b>	65
<b>Geography</b>	103
<b>Language</b>	155



# CONTENTS

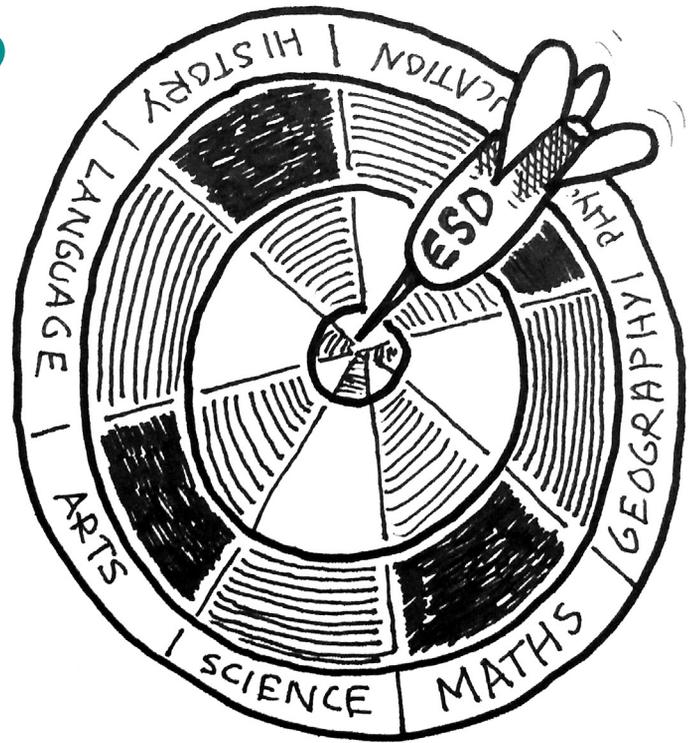
*ESD needs to be reflected in the content of what teachers must teach and the pedagogy they implement. Embedding ESD into core subjects is one of the most effective and efficient ways to achieve SDG Target 4.7*



## INTRODUCTION

	<b>What is the purpose of this guidebook?</b> .....	13
<b>1.0</b>	<b>Transforming education to shape a more sustainable world</b> .....	15
<b>2.0</b>	<b>What is embedding?</b> .....	17
	2.1 From periphery to centre.....	17
	2.2 Promoting double-purpose learning.....	19
<b>3.0</b>	<b>Making a case for embedding ESD in textbooks</b> .....	23
	3.1 Efficient and viable intervention.....	23
	3.2 Improving content and pedagogy.....	23
<b>4.0</b>	<b>How to embed ESD in textbooks</b> .....	25
	4.1 Developing competency-based learning units.....	25
	4.2 Selecting ESD themes, topics and issues.....	26
	4.3 Making ESD issues ‘matter’ to students.....	26
	4.4 Assessment in alignment with ESD.....	31
<b>5.0</b>	<b>Outline of the guidebook</b> .....	31
<b>6.0</b>	<b>References</b> .....	32

# What is the purpose of this guidebook?



**THE INTERCONNECTED** environmental, economic, social and political challenges facing humanity call for education that enables young people to engage creatively and responsibly with the world. We need education for sustainable development – education that ‘empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity’ (UNESCO, 2014a, p. 12).

This guidebook aims to support textbook authors and publishing houses to produce a new generation of textbooks that integrate education for sustainable development (ESD). By doing so, it aspires to make learning relevant and effective. It also contributes to the implementation of the 2030 Agenda for Sustainable Development (United Nations, 2015), adopted by 193 UN Member States in 2015. At the core of the 2030 Agenda are 17 Sustainable Development Goals (SDGs) – the shared global ambition and intergovernmental commitment up to 2030 (see Box 1). Although this guidebook focuses on school textbooks, its approach should be seen as part of a wider process of transforming a variety of educational media – including images, audio and video materials – to engage students in immersive learning.

The guidebook builds on existing work in ESD and related areas such as global citizenship education, peace education, human rights education, environmental education, development education, global education, global learning and others. It is intended for the stakeholders in textbook development: education ministries, national curriculum authorities, textbook writers and publishers. It can also be useful for international and non-governmental organizations that have a mandate for improving the quality of

education; teacher educators; teachers; principals and head teachers; school boards; researchers and practitioners of ESD and related education. It is aimed at an international audience and recognizes that the understanding of ESD and the practice of it is contextual and the priority of sustainable development issues may vary across education systems. Textbook authors and educators are encouraged to use this guidebook as a source of ideas, tools and methods that can help to enrich content and pedagogy and complement their own individual and institutional strategies.

What this guidebook offers is concrete guidance for textbook authors on how to reorient the existing curriculum content towards peace, sustainable development and global citizenship. It primarily addresses authors of textbooks for primary and secondary education in four subjects: mathematics, science, geography and language (English). The selection of these subjects was a pragmatic and strategic decision rather than a reflection of their importance in relation to others. Time constraints prevented other subjects from being included and those selected are ones that will optimize efforts to mainstream ESD. Three of the subjects – mathematics, science and language – are usually core compulsory subjects in national curricula. Geography is a subject that naturally lends itself to ESD and provides rich insights into embedding that could be useful for other subject areas as well.

## Box 1



# SUSTAINABLE DEVELOPMENT GOALS



1. **NO POVERTY** – End poverty in all its forms everywhere.
2. **ZERO HUNGER** – End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3. **GOOD HEALTH AND WELL-BEING** – Ensure healthy lives and promote well-being for all at all ages.
4. **QUALITY EDUCATION** – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. **GENDER EQUALITY** – Achieve gender equality and empower all women and girls.
6. **CLEAN WATER AND SANITATION** – Ensure availability and sustainable management of water and sanitation for all.
7. **AFFORDABLE AND CLEAN ENERGY** – Ensure access to affordable, reliable, sustainable and clean energy for all.
8. **DECENT WORK AND ECONOMIC GROWTH** – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. **INDUSTRY, INNOVATION AND INFRASTRUCTURE** – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10. **REDUCED INEQUALITIES** – Reduce inequality within and among countries.
11. **SUSTAINABLE CITIES AND COMMUNITIES** – Make cities and human settlements inclusive, safe, resilient and sustainable.
12. **RESPONSIBLE CONSUMPTION AND PRODUCTION** – Ensure sustainable consumption and production patterns.
13. **CLIMATE ACTION** – Take urgent action to combat climate change and its impacts.
14. **LIFE BELOW WATER** – Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. **LIFE ON LAND** – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. **PEACE, JUSTICE AND STRONG INSTITUTIONS** – Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. **PARTNERSHIPS FOR THE GOALS** – Strengthen the means of implementation and revitalize the global partnership for sustainable development.

## 1.0

# Transforming education to shape a more sustainable world

Given the accelerating demographic, geopolitical, technological and environmental changes and their associated risks and opportunities, there is an increasing consensus today on the need to reorient education to meet the challenges of the 21st century (see Box 2).

The critical task of education in our interconnected and interdependent world is not only to enable people and communities to adapt to change at local and global levels, but to foster capabilities to transform the world so we can more fully realize our humanity and protect the biophysical environment on which we depend. This guidebook helps to address this need to transform education to face and shape the future.

While schools are supplemented increasingly by other aspects of social life, they remain essential for developing young people's understanding of the world through academic learning and the promotion of the norms and values of society. Too often, however, school education fails to create a reflective ethos and a sense of responsibility for a shared humanity and the future of our planet. Our proposal is to begin by taking the concrete step of transforming textbooks – the teaching and learning resources that are most prevalent around the world and the ones closest to students.

In this guidebook, education for sustainable development (ESD) is used as a broad term encompassing the transformative education efforts included in SDG 4.7. It includes the content (themes and topics), knowledge, skills, values, attitudes or dispositions and pedagogies to foster competencies needed to shape more peaceful and sustainable societies.<sup>1</sup> For elaboration on the concept of sustainable development and the significance of its fundamental principles in education, please refer to Notes on Key Concepts 1.



## Box 2



## Sustainable Development Goal Target 4.7

SDG Target 4.7 is an acknowledgment of the critical importance of education for sustainable development, global citizenship education and other transformational education movements for a sustainable and peaceful future for all:

“by 2030 ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development” *United Nations (2015a)*

A global indicator of SDG 4.7 is the ‘extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in (a) national education policies, (b) curricula, (c) teacher education and (d) student assessment’ (UNESCO, 2016a, p. 79). SDG Target 4.7 provides an unprecedented opportunity to mainstream education for sustainable development into school education.

<sup>1</sup> We are fully cognizant of the reality that ESD as a term and concept has come to be associated with particular movements, approaches, stakeholders and topics. With this guidebook, we use ESD as an umbrella term to facilitate communication by avoiding cumbersome multiple definitions. However, we do not wish to suggest that ESD is the only reasonable overarching, umbrella term for related education such as global citizenship education, peace and human rights education, global education, global learning, environmental education, development education and others that come under SDG 4.7. MGIEP proposes to take an integrated approach to the implementation of SDG 4.7. Our choice does justice to the aspirations of ESD as education for ‘sustainable development’, which is now made concrete in the shared global ambition of 17 SDGs.

Notes on key concepts 1

## Understanding sustainable development and the ESD approach

Over decades, the United Nations has aspired to make sustainable development an overarching guiding principle for ensuring a better future for all. The 2015 adoption of the Sustainable Development Goals (SDGs) is clearly a milestone in this regard. The foundational concept of ‘sustainable development’ was described by the 1987 Brundtland Commission Report as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (World Commission on Environment and Development, 1987). It has remained a continuous challenge to interpret and apply this principle to relevant issues at all levels of society in a rapidly changing world.

The term ‘development’ has often been associated exclusively with economic growth. In the mainstream policy discourse, however, ‘sustainable development’ has become a paradigm for thinking about development in which environmental, social and economic considerations (see Figure 1) are balanced in the pursuit of improved quality of life and universal values such as human rights.

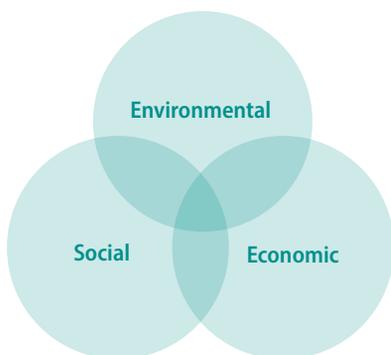


Figure 1: Classic dimensions of sustainable development

Sustainable development is seen as a process towards a goal. With growing awareness of the crucial importance of good governance, a political dimension can be added to the traditional three dimensions of sustainable development, underscoring the role of public participation in community and governmental decision-making (Figure 2).

Additionally, negotiations among stakeholders of the economic, environmental, social and political dimensions of sustainable development have to respect cultural diversity.

To shape more peaceful and sustainable societies, all these development dimensions (economy, society, environment, politics, culture) have to be

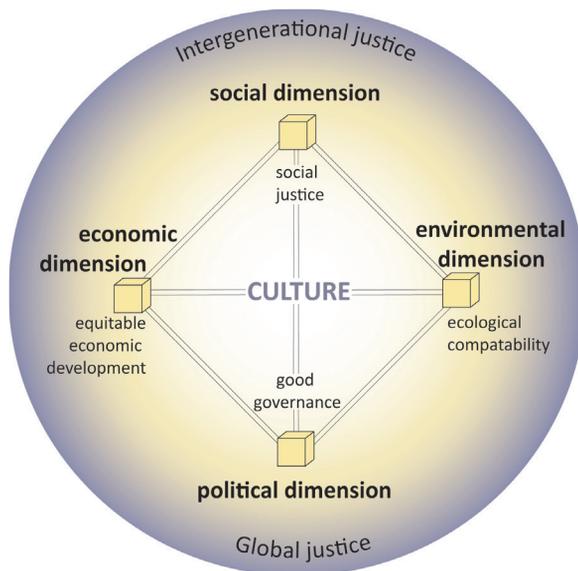


Figure 2: Dimensions and main goals of sustainable development. Source: Curriculum Framework ESD, Schreiber and Siege (eds.) (2016) p. 89

considered as having equal significance, being mutually aligned in their goals and managed democratically by the institutions responsible, including stakeholders and citizens translating SDGs into individual and collective action.

When applied to education, sustainable development cannot be prescriptive, that is, defined by ‘planetary boundaries’ or ‘social thresholds’ as in political resolutions. In education, this principle offers orientation in the learning process and fosters sustainability as a ‘frame of mind’ (Bonnett, 2002), as a basic attitude and awareness of interconnectedness. Education for sustainable development (ESD) is directed at enabling self-determined participation in the transformation of unsustainable paradigms, policies and practices. It emphasizes the democratic participation of individuals and local, national and global citizens in making the changes needed to move towards a sustainable society. ESD and related educational approaches are fostering competencies that enable students to find sustainable solutions to demanding issues and prevent conflicts. ‘With its overall aim to develop cross-cutting sustainability competencies in learners, ESD is an essential contribution to all efforts to achieve the SDGs, enabling individuals to contribute to sustainable development by promoting societal, economic and political change as well as by transforming their own behaviour’ (UNESCO, 2017a).

## 2.0

## What is embedding?

We live in an increasingly globalized world that is facing grave ecological, economic and societal threats, ranging from water and energy scarcity to the rise of violent extremism. More than ever, the quality of education is determined by whether students have access to content and pedagogy designed to foster learning to live together on a planet under pressure and with a shared respect for human dignity. In other words, education for sustainable development and global citizenship needs to become a core guiding principle of educational change, for which there is an international consensus and momentum (see Box 2).

This section explains what we mean by ‘embedding’. While the term ‘mainstreaming’, as in the global indicator of SDG Target 4.7 (see Box 2), is commonly used to refer to a process of incorporating or including ESD in different aspects of education systems, we use ‘embedding’ intentionally to refer to a particular strategy for mainstreaming, as discussed below.

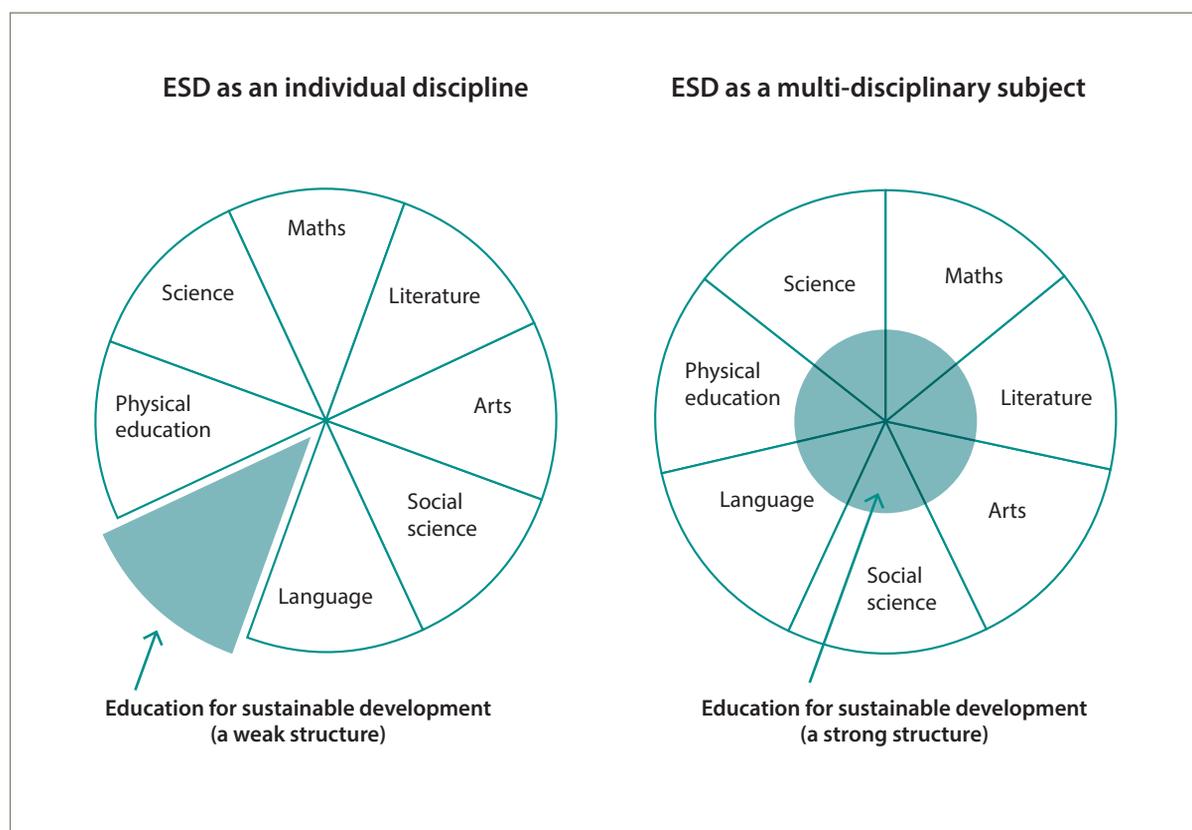
## 2.1

### From periphery to centre

There has been a long-standing international consensus that ESD should be ‘embedded in the whole curriculum, not as a separate subject’ (UNESCO, 2006b, p. 17). Already in 1992, Chapter 36 of Agenda 21, which consolidated the international discussion on ESD, called for integrating ESD – then conceptualized as the combination of development education and environmental education – in all disciplines. Underlying such calls for an interdisciplinary and integrated approach to ESD is the acute realization of the cross-cutting and interconnected nature of sustainable development challenges.

In this guidebook, we use the term ‘embedding’ to refer to incorporating ESD as an integral element of curricula and other aspects of formal education, not as an ‘add-on’. As Figure 3 illustrates, ESD is at the core of each subject rather than being taught as an addition on the fringes of the curriculum. Embedding ESD in all subjects will ensure a stronger and more effective result. ESD goes far beyond education ‘about’ sustainable development. Embedding does justice to the concept of education ‘for’ sustainable development by putting its values and principles at the core of education.

*ESD goes far beyond education ‘about’ sustainable development. Embedding does justice to the concept of education ‘for’ sustainable development by putting its values and principles at the core of education*



Source: Adapted from UNESCO (2006a), p. 90

Figure 3: Comparing weak and strong ESD structures

Table 1: Four responses to the challenge of sustainable development and corresponding ESD mainstreaming strategies

Responses to the challenge of sustainable development		Corresponding ESD mainstreaming strategies
(a) Denial	It's a hype that will go away	No action
(b) Bolt on	Add a 'green aspect' to a curriculum or a programme	Adding on
(c) Built in	Important enough to integrate in all we do	Embedding
(d) Whole system redesign	We need to rethink the very foundations of what we currently do	Infusion

Source: Responses to the challenge of sustainable development, adapted from Sterling 2004 as cited in Lotz-Sisitka et al (2015) p.73

*The ultimate goal of embedding is infusion, that is, sustainable development will have become so deeply integrated in society and infused through all forms of education that it becomes indiscernible, an underlying value orientation and a societal norm*

Mainstreaming ESD into formal education involves different approaches, ranging from 'conventional' ones that conform to existing school systems and structures to 'innovative' ones where there is a radical force to transform existing institutional structures (Wals, 2009, p. 49). Stephen Sterling's model of responses to the challenge of sustainability (see Table 1) is useful in helping us position embedding: while being critical of the 'bolt-on' approach (b), embedding can be seen as located in the 'built-in' approach (c) but with the long-term goal of achieving 'whole-system redesign' (d). This last response (d) involves 'a paradigm shift and a transition towards doing better things differently (transformation) rather than doing what we do better (optimization)' (Lotz-Sisitka et al, 2015, p. 73).

Ideally, mainstreaming ESD should happen within a 'whole-school' approach, with ESD values and principles being reflected in the ethos and mission of the school and being central to the professional development of its teachers. Obviously, transformation needs to take place not only in school textbooks but also in education policies, the curriculum,<sup>2</sup> teacher education and student assessment (see Box 2 for the global indicator of SDG Target 4.7). The ultimate goal of embedding is infusion, that is, sustainable

development will have become so deeply integrated in society and infused through all forms of education that it becomes indiscernible, an underlying value orientation and a societal norm (see Box 3).

**Box 3**

**The metaphor of embedding**

The metaphor of embedding describes the process of integrating a desirable element deeply into a system. It is built firmly into the system, as opposed to merely being bolted on to it. The embedded element, however, is still discernible and it does not immediately transform the system, although it may well improve its function. Embedding is a strategy that opens up possibilities for transforming the education system from within by paving a way to an interdisciplinary curriculum, issue-based learning and whole-school approaches (see Box 6 and Box 9).

The metaphor of infusion, on the other hand, describes the process of a desirable essence permeating and transforming the milieu in which the system operates. When infusion refers to the process of dissolving flavours from plant material, an infusion is also the name for the resultant liquid or solution. In this sense, infusion is a strategy for ESD integration that is deeper than embedding and is an ultimate solution.

While there is a widely recognized need to mainstream ESD not only in all aspects of school life but also at all levels (from early childhood to higher education) and in all types (formal, non-formal and informal) of education, the purpose of this guidebook is not to reiterate the need for a radical transformation of the entire education system – which is, for most countries, an unrealistic proposal. The guidebook instead proposes feasible embedding interventions that will make the most of the current situation, where teachers are prepared to teach subjects and

<sup>2</sup> The word 'curriculum' has a range of meanings in different countries and contexts. In this guidebook, we use the term for a mandatory government framework for content and pedagogical stipulations in formal education. We also refer to the existence of school curricula in some places, implementing the mandatory national/regional curriculum by defining content, pedagogical means and organizational implementation in local schools. As summarized in *Education for Sustainable Development Sourcebook* (2012, p. 8), UNESCO developed tools to reorient a curriculum to address sustainable development during the United Nations Decade of Education for Sustainable Development (2005–2015). For example, the *Education for Sustainable Development Lens: A Policy and Practice Review Tool* 'Review tool 9: ESD integration in the curriculum' provides a way for analyzing the extent to which ESD is integrated in the curriculum at national and school levels (UNESCO, 2010, pp. 68–69). The *Education for Sustainable Development Toolkit* contains eight exercises for reorienting a curriculum to address sustainability and holding community forums to gather public opinion related to curricular change (UNESCO, 2006, pp. 84–102). 'Project Y' is a tool to integrate sustainability into existing lesson plans and units (UNESCO, 2006, pp. 87–88; UNESCO, 2012, p. 10).

textbooks are subject based (although issue-based textbooks do exist). At the same time, it is hoped that these interventions will open up opportunities for transforming the widespread silo structure of school subjects and disciplines, as explained later in this chapter (see section 3.2).

Given the urgency of putting the world on a sustainable path, sustainable development can and should find an appropriate place in the curricula of all grade levels and subject areas. This guidebook demonstrates that the core curriculum usually provides sufficient accommodative space to address sustainable development meaningfully, and that transforming education for a better future for all can begin today through the ingenuity and commitment of the stakeholders of textbook development.

## 2.2 Promoting double-purpose learning

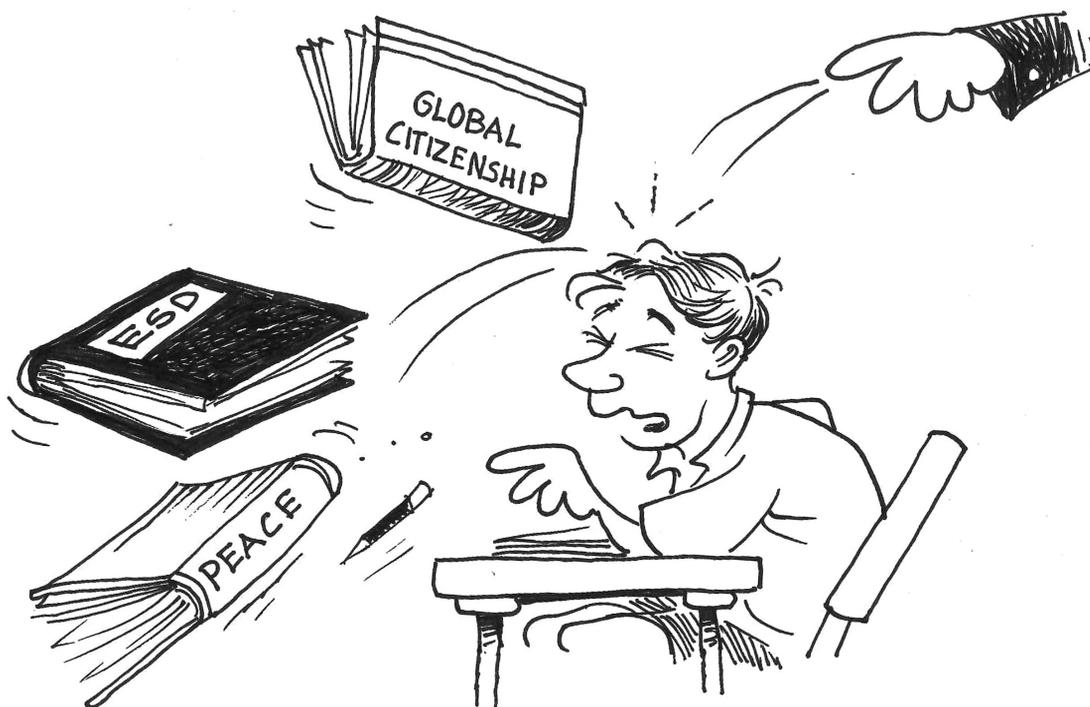
Embedding is not about inserting new thematic content into an already overcrowded curriculum, which would make it impractical – both time and content wise – for the teacher and textbook author. Nor is it about removing or minimizing the importance of academic content. Instead, it is about reorienting subjects into serving a more socially and globally relevant purpose: that of contributing to a sustainable,

just and peaceful world, with young people motivated, prepared and empowered to address persistent and emerging local and global challenges.

Embedding contributes to learning outcomes – both in the domains covered by SDG Target 4.7 and the school subjects. UNESCO (2004) has identified two key dimensions of educational quality: (1) the promotion of learners' cognitive development and (2) the cultivation of the skills, knowledge, values and attitudes necessary for responsible, active and productive citizenship. Embedding, therefore, contributes directly to the long-established quality agenda of education, as well as the integrated and transformative agenda for sustainable development. Too often, the emphasis on traditional academic learning in examination-oriented systems has undermined the 'social, humanistic and moral purposes of education' at the heart of SDG Target 4.7 (UNESCO, 2016b, p. 288). Embedding, therefore, strategically promotes double-purpose learning, where students acquire subject knowledge and skills and, at the same time, learn how to contribute to a sustainable transformation of society – they learn to live together with a deep respect for the environment and dignity for all.

There are at least two practical reasons why educators, concerned with improving student achievement, should consider embedding ESD in formal education. First, the shift towards the ideals of an inquiry-based curriculum in the teaching of the core subjects has momentum that crosses national boundaries.<sup>3</sup>

*Too often, the emphasis on traditional academic learning in examination-oriented systems has undermined the 'social, humanistic and moral purposes of education' at the heart of SDG Target 4.7*



<sup>3</sup> See, for example, OECD (2009) *PISA 2009 Assessment Framework: Key Competencies in Reading, Mathematics and Science*, Paris: OECD; National Council for Education Research and Training (NCERT) (2005) *The National Curriculum Framework*, New Delhi, India: NCERT.

## Box 4

### Examples of promoting double-purpose learning through mathematics and science textbooks

For many people, embedding ESD into mathematics is counter-intuitive and sounds like a misguided approach that dilutes or even pollutes the subject content. As pointed out in the Mathematics chapter in this guidebook, however, embedding not only ‘show[s] students that mathematics is relevant to the real problems in their communities, but it also enables students to understand the complex mathematics because it relates to situations they know well’.

For example, mathematics offers students tools for measuring and comparing that can, in turn, help them identify discrimination and inequities or quantify the effects of actions implemented to address these injustices. The Mathematics chapter introduces an example of connecting the body mass index (BMI) measurement with issues of undernourishment in the developing world and the SDGs on eliminating poverty and hunger. This enables students to understand mathematics while, at the same time, educating and engaging them critically on issues of inequality and evaluating progress towards addressing such issues (see the Mathematics chapter). A mathematics textbook, while being an educational tool for teaching mathematics, can develop students’ capacity to contribute to shaping a more sustainable world.

In science, links to sustainable development are more clearly identifiable. For example, a science textbook, while teaching ecosystem dynamics, might discuss the issue of declining bee populations as an indicator of ecosystem disruption caused by human action. Students, through science learning, will be encouraged to view themselves as having an active role to play in decision-making and problem solving when it comes to interconnected scientific, technological, social, economic, environmental and political problems (see the Science chapter).

Embedding is a strategy that can be used in subject-centred and examination-oriented systems, with the ultimate aim of transforming them from within. Embedding aspires to contribute to transforming school curricula where mathematics and science are taught like dogmas and social studies fail to provide meaningful opportunities to learn about interconnectedness and appreciate diversity. Barring notable exceptions, ESD efforts have largely been out of sync with the efforts to reform how mainstream disciplines are taught in school to foster critical-thinking and problem-solving abilities. It is this gap that this guidebook fills.

Second, there is general consensus that education systems should provide opportunities for young people to develop certain key competencies that allow them to navigate an increasingly complex world and engage creatively and responsibly with it. There is also an increasing demand that we should start measuring these competencies. In 2013, for example, the Programme for International Student Assessment (PISA) Governing Board decided to explore in the 2018 PISA an assessment of ‘global

competency’, which is closely aligned to ESD.<sup>4</sup> In the context of monitoring SDG Target 4.7, UNESCO and the International Association for the Evaluation of Educational Achievement (IEA) established an official agreement to collaborate in the area of measuring ESD and global citizenship education. IEA administers the International Civic and Citizenship Education Study, which will be one of the major sources of data collection for SDG Target 4.7.

Whereas ESD competency models are still under much debate and development (Wolbring and Burke 2013; Scheunpflug 2014; O’Donoghue 2015), there is nevertheless some agreement on the kinds of competencies required for realizing sustainable development, albeit with different emphases (see, among others, Roth, 1971; OECD, 2005; de Haan, 2010; Wals, 2010; UNECE, 2011; Wiek et al, 2011; Schreiber and Siege, 2016; Halinen 2017; UNESCO, 2017a).<sup>5</sup> Box 5 presents an indicative list of ESD competencies compiled to support curriculum developers, textbook authors and teachers in identifying competencies that can be related to and integrated with subject-specific content, knowledge and skills.<sup>6</sup>

<sup>4</sup> Global competency is defined as ‘the capacity to analyse global and intercultural issues critically and from multiple perspectives, to understand how differences affect perceptions, judgments, and ideas of self and others, and to engage in open, appropriate and effective interactions with others from different backgrounds on the basis of a shared respect for human dignity’ (OECD, 2016, p. 4).

<sup>5</sup> A considerable number of key competencies have been identified or derived from ESD concepts. They are complementary to a holistic idea of competency. The underlying theory of a cumulative process of competency development is manifested, for instance, in the singular use of the term ‘global competency’ (OECD, 2016), which consists of numerous partial competencies gradually acquired in the learning process. The ESD competencies included in Box 5 are intertwined and overlapping, and they cannot be separated from general basic competencies, such as creativity. See also Notes on Key Concepts 2: elaborating on the knowledge-action gap and competency models.

<sup>6</sup> The catalogue of ‘learning objectives’ suggested for ESD in connection with each of the 17 SDGs (UNESCO, 2017a) provides practical help in this context. They correspond to ‘partial competencies’.

The objectives of ESD embrace a broad and complex range of knowledge, skills, dispositions, values and ways of thinking that underlie people's worldviews and daily behaviour and enable them to participate in decisions that will improve the quality of life of everyone without damaging the planet. We should also keep in mind that not all

desirable competencies can be measured, and that they will vary with the context. The ultimate responsibility to create opportunities for students to develop ESD competencies rests with teachers, but they can be greatly supported by textbooks that facilitate inquiry-based and action-oriented teaching-learning processes.

*The objectives of ESD embrace a broad and complex range of knowledge, skills, dispositions, values and ways of thinking that underlie people's worldviews and daily behaviour and enable them to participate in decisions that will improve the quality of life of everyone without damaging the planet*

#### Box 5

### Indicative list of ESD competencies

**Acquiring knowledge.** The ability to collect data and information in a largely self-organized and target-oriented manner from different sources and with the help of various tools; to assess their quality and to construct knowledge that is helpful for the solution of issue-related tasks.

**Solving issues, problems, conflicts.** The ability to contribute to the solving of issues, problems and conflicts at the local, national and global level by overcoming excessive self-interest, socio-cultural barriers, racism, ideological differences and violence through negotiating solutions.

**Thinking critically.** The ability to question norms, practices, opinions, attitudes, claims and decisions – including self-criticism and the acknowledgement of misdoings – when reflecting on unsustainable developments with the intention to contribute constructively to sustainable solutions.

**Communicating and negotiating.** The ability and readiness to communicate constructively and effectively in spoken and written languages as a pre-condition for an effective learning process and with the intention to negotiate over issues.

**Dealing with systems.** The ability to analyze systems and development processes; to recognize interrelations between local, national and global levels of acting and to assess the effect of human interventions.

**Facing the future.** The ability to analyze risks and to evaluate multiple futures, to link innovations with sustainable development goals, to create individual and collective visions, to assess the consequences of actions and decisions and to deal with uncertainty and changes.

**Reflecting on values.** The ability and willingness to reflect on own and others' norms and values, to negotiate sustainability principles and goals (in a context of conflicts of interest, uncertain knowledge and contradictions) with a readiness to revise one's own value system and to ensure a balance between pluralism and universal values.

**Participating and collaborating.** The ability and readiness to participate in sustainable transformation processes, to individually and collectively develop and implement ways of action towards a sustainable development goal and to intensively and responsibly collaborate with others.

**Changing perspectives.** The ability to reflect on others' situations and feel empathy for them, to critically reflect upon diverse perspectives and see things differently, to develop an alternative frame of reference by changing one's own previously unquestioned worldviews.

**Thinking and acting inclusively.** The ability to cooperate with people regardless of their gender, religion, ethnic and social origin, cognitive, physical and psychological precondition and the willingness to practise tolerance, to contribute to integration and appreciate diversity.

**Showing solidarity and responsibility.** The ability and willingness to develop an attitude of global citizenship, to show solidarity for others suffering from inequity and to share the responsibility for ecological risks.

*Notes on key concepts 2***Understanding competencies**

The ultimate goal of ESD is to foster deliberate transitioning among knowing, thinking, valuing and acting. As Glasser (2007, p. 42) succinctly puts it, ‘awareness of a problem, accessibility of extensive information on its origins and impacts, and even stated concern about it, do not guarantee action ...’. There is still a long way to go before we can fill the gap between our stated desire for a more sustainable world and our everyday actions. A number of studies have shown that learners acquire knowledge, understanding and skills but often lack dispositions – that is, the attitude and determination – to use them (see, for example, Asbrand, 2009). Educational reasons for the knowledge-action gap often result from a lack of insight into complex developments and formal learning processes that do not allow for the active and self-reliant involvement of the students.

The curricular documents of different countries use different terms to refer to knowledge, skills, attitudes, values and types of behaviour. Fundamental ethical principles, attitudes and values are often referred to in preambles and are rarely integrated into curricula explicitly. Knowledge is sometimes reduced to declarative knowledge or used as an all-encompassing term for the outcome of learning and research. Certain classifications, however, have become standard in many countries, including competencies, skills, themes/topics, teaching and learning methods as well as performance monitoring and assessment.

A widely accepted definition of competencies by the psychologist Franz Emanuel Weinert (2001a, pp. 27–28) is that they are ‘cognitive capacities and skills that individuals have or can acquire in order to solve specific problems and to successfully and responsibly use connected motivational, volitional and social readiness and abilities for solving problems in variable situations’ (translated from the German).

This definition not only underlines the integrative character of competencies but also underscores that they have to be developed by the learners themselves. They consist of various elements and are acquired during action on the basis of experience and reflection (UNESCO, 2017a). We need knowledge, skills, motivation, readiness and an attitude based on reflected values to solve problems responsibly (see Figure 4). Competencies are dispositions for meeting certain requirements, for finding and implementing sustainable solutions. ESD competencies (see Box 5), once developed, can help to face present and future challenges in variable situations.

The notion of competencies was mainstreamed into education policy circles by the Organization for Economic Co-operation and Development’s Definition and Selection of Competencies (DeSeCo) project, which was initiated in late 1997 and completed in 2003. In 1997, OECD member countries launched the Programme for International Student Assessment (PISA) to monitor the extent to which students near the end of compulsory schooling have acquired the competencies essential for full participation in society. The 2018 assessment will focus on global competency (see OECD, 2016).

In a number of countries, it has become customary to use the concept of competencies to describe the result of the teaching and learning process and to treat the identification of competencies or intended learning outcomes as of great relevance to the choice of content and the overall pedagogic design. Instead of competencies, some prefer to use the term ‘pedagogical principles’ to refer to principles that guide teaching and learning processes (see the Geography chapter). More important than individual pedagogical tools is their complementarity in promoting a learning process.



Figure 4: OECD's competency model

## 3.0

## Making a case for embedding ESD in textbooks

Textbooks present a largely untapped opportunity to integrate peace, global citizenship and sustainable development into formal education. Clearly, textbook-led curriculum development alone is not sufficient to foster the skills, dispositional and behavioural learning outcomes called for by ESD. The following section explains why this guidebook focuses on embedding ESD into the textbooks of core subjects.

## 3.1

### Efficient and viable intervention

To date, subject content and textbooks have been at the heart of formal education, often influencing many aspects of school education from teacher education to classroom practices. Still, in many countries, textbook revision is the preferred – in some cases the only – mode of curriculum development. In countries where the modern education system was developed under colonialism, textbooks – more than the syllabus or curriculum – dictate what teachers teach. Even in our increasingly digital era, school textbooks remain ‘the most visible part of the curriculum’ and they are often seen as ‘authoritative sources for the transfer of knowledge and social values’ (Georgescu and Bernard, 2007, pp. 5–7). For many people, textbooks have been the first books they have ever read and studied in depth (Lässig, 2009, p. 2). Many education reform programmes across the world view the improvement of the quality of textbooks as a fundamental objective and have adopted policies and measures to that end.

Producing additional resource materials or providing teacher education programmes in ESD concepts and pedagogies (most often manifested as issue-based and project-based learning activities) is not sufficient. ESD needs to be reflected in the content of what teachers must teach and the pedagogy they implement, rather than being treated as an add-on to the main curriculum. Given the number of instructional hours dedicated to these subjects and their mandatory and examinable status, embedding ESD into core subjects is one of the most effective and efficient ways to achieve SDG Target 4.7 (see Box 2).

Embedding also produces a change that will leave a long-term legacy. Textbooks are not often completely revised. In certain countries, there is still a lack of – or very limited – teacher preparation and training, with the result that teachers rely on teaching ‘to the book or text’.<sup>7</sup> Teachers often take their cues from school textbooks. Although improving the quality

of textbooks is not a panacea, it is an important step towards transforming education for realizing more peaceful and sustainable societies. A policy paper by the Global Education Monitoring Report has called on governments to review and revise the content of their textbooks urgently, in line with the core values of the 2030 Agenda for Sustainable Development. It calls for these core values to be built into the national guidelines used during textbook review and taught in workshops for textbook writers and illustrators (UNESCO, 2016c).

## 3.2

### Improving content and pedagogy

By carefully integrating real-life and cross-cutting issues – such as climate change, poverty and migration – into textbooks in ways that students can relate to, authors can improve both content and pedagogy to achieve more meaningful learning in school subjects as well as in ESD. Embedding ESD brings textbooks up to date by integrating the latest insights into the complex and interconnected local and global challenges in the subject content. It supports learners’ engagement in deeper learning by transforming textbooks from a vehicle for transmitting knowledge into educational resources that enable students to engage constructively with the world. Embedding ESD into primary and secondary textbooks enhances meaning for learners at an age when they need to relate to and make sense of what they learn. As the Geography chapter in this guidebook puts it, content and pedagogy are both improved as ‘abstract knowledge is made concrete, understandable and meaningful through contextualization ... and facilitating pedagogical approaches’.

Enriched issue-based, problem-oriented content can open doors for transformative ESD pedagogy, here loosely defined as the student-centred, inquiry-based pedagogical approaches aimed at developing the agency of learners in participating in and acting

*ESD needs to be reflected in the content of what teachers must teach and the pedagogy they implement. Embedding ESD into core subjects is one of the most effective and efficient ways to achieve SDG Target 4.7*

<sup>7</sup> Producing high-quality textbooks with ESD at their core is cost effective compared with providing recurrent teacher education in ESD, global citizenship education, human rights education, peace education and others.

## Box 6

### Promoting an interdisciplinary approach and issue-centric learning

Key topics such as ‘globalization of economy and labour’, ‘peace and conflict’ or ‘global environmental change’ can hardly be taught from the perspective of a single school subject. Issue-centric approaches identify socially relevant real-world issues with curriculum content to engage students with wider issues of sustainable development. By posing recognizable real-world problems for investigation as the central focus of their studies, learners identify wider social, environmental, economic and political impacts within the subject-specific material for evaluation and future action. This expands opportunities for overcoming fragmentation of knowledge in the usual silo structure of school subjects.

An interdisciplinary approach engages students meaningfully in sustainability issues by allowing them to analyze a complex topic in more than one subject. This can either be achieved by an individual teacher expanding the contours of the subject area or by a cross-curricular approach. Instituting a cross-curricular approach may not be easy in many schools but it has, nevertheless, been achieved in numerous cases, allowing two or more subjects to cooperate over a sustained period of time or introducing project-based learning<sup>10</sup> phases in the school calendar. An interdisciplinary approach, often guided by one subject, over a longer period than a few lessons, fosters ESD key competencies and enables students to engage in complex issues deeply. Schools and their teachers need various forms of support to promote cross-curricular activities: cross-referencing between textbooks of different subjects, developing supplementary materials focusing on key ESD issues that can be used across subjects, instituting a scheme or programme to invite experts to school, curating online clearing houses on useful interdisciplinary teaching and learning resources, and so on.

on sustainable development issues.<sup>8</sup> In essence, ESD pedagogy constitutes approaches that focus on learners as active social agents from particular locations. Like progressive pedagogies employed for particular school subjects, it is informed by constructivist learning theories, which posit that learning occurs as students engage actively in a process of constructing meaning and knowledge.<sup>9</sup> School subjects have their own pedagogical approaches and methodological traditions and it is important, therefore, that textbook authors relate ESD pedagogy to a particular domain. For example, the Science Chapter in this guidebook refers to socio-scientific issues-based approaches that have been widely used in science classrooms.

In addition, embedding ESD into textbooks can pave a way to a more interdisciplinary curriculum in schools, which enhances issue-centric learning (see Box 6). An interdisciplinary curriculum is even more effective when it is place based, allowing the in-depth and authentic study of select local issues (Stevenson, 1997). ‘In-depth’ means that students spend a sustained period of time examining and debating these questions, while ‘authentic’ signifies that students, through systematic inquiry, construct their own meaning and produce knowledge that has an immediate social value in making a judgment on a specific issue that is real and meaningful to them (Newmann and Wehlage, 1995). The interconnectivity between the local and the global should be part of students’ investigations and discussions in their effort to understand and develop meaningful responses to local sustainability issues.

As an integral element of improving content and pedagogy, there is a need to revisit the very nature of teaching and learning materials used in schools. Today, information of all sorts is readily available through information and communication technology (ICT) and

<sup>8</sup> There have been efforts to provide evidence that ESD (as defined by UNESCO in the context of the UN Decade of ESD) contributes to quality primary and secondary education (see, for example, Laurie et al, 2016) or to define essential components of ESD pedagogies (Eilam and Trop, 2010). However, much literature on ESD in a narrow sense is normative or descriptive in nature and represents a modest empirical research base on ESD pedagogies.

<sup>9</sup> A number of different constructivist theories by Jean Piaget, Lev Vygotsky and later Jerome Bruner, Kersten Reich, Keith Taber and many others, have led to the development of teaching and learning methods and contributed to an extensive list of relevant publications on pedagogies in a number of languages. ESD pedagogies are informed by experiential learning, problem-based and project-based learning (see English and Kitsantas, 2013, for useful insights into how to foster student responsibility for learning in different phases in problem- and project-based learning), social learning (Wals, 2007) and critical pedagogy, among others. James Coleman (1976, 1979) has described traditional learning as ‘information assimilation’ and characterized experiential learning as the opposite of traditional learning. This familiar call for a shift from traditional to progressive pedagogies is echoed in a shift from ‘passing on knowledge’ to ‘understanding and getting to the root of issues’ (Tilbury, 2011, p. 25), ‘a shift from viewing education as a delivery mechanism to a lifelong, holistic and inclusive process’ (*Ahmedabad Declaration*, 2007, p. 1) or the ‘move from teacher-centred to student-centred lessons and from rote memorization to participatory learning’ (UNESCO, 2012a, p. 15) called for by ESD.

<sup>10</sup> Project-based and problem-based learning pedagogies are styles of inquiry-based learning often used in ESD implementation. There are identifiable differences between the two (see the Science chapter, section 3.2.1). Project-based learning approaches (which date back to the early 20th century) usually require the completion of ‘real’ tasks, entailing the application of acquired skills, or are ongoing projects with tangible ‘hard’ outcomes. In this respect, it is a competency-based approach. Problem-based learning is related (and is much more recent as a recognized strategy) but uses case studies as examples of real-world problems (which may be derived from a scenario or problem set based on authentic data). When applied to ESD, project- and problem-based learning approaches require students to propose sustainable solutions that balance interconnected dimensions of sustainable development (see Notes on Key Concepts 1).

ready-made definitions of almost everything students learn (and do not learn) in school curricula are just a click away. This opens opportunities for deeper learning using the rich and easily available data on diverse life phenomena. At the same time, it gives further support to the importance of fostering ESD competencies. Today's students need not so much to memorize information as to learn what to do with it – 'analyse it; make sense of its abundance and complexity; cooperate with others to synthesize information; and communicate

the results' (Laurie et al, 2016, p. 227). Publishers are increasingly exploring ICT-based teaching and learning materials to supplement, update or replace paper-based textbooks. This will not lessen the value of this guidebook in the years to come. Rather, developers of content for all educational media can take cues from this guidebook for creating relevant and engaging issue-centric content coupled with student-centred and inquiry-based pedagogical approaches.

*Today's students need not so much to memorize information as to learn what to do with it ... developers of content for all educational media can take cues from this guidebook for creating relevant and engaging issue-centric content*

## 4.0

# How to embed ESD in textbooks

Embedding is about enabling students to develop a keen understanding of academic content and to apply their knowledge and skills to problems not just in the classroom but in their communities, careers and their civic lives. There is no school subject for which ESD is not relevant. Each subject chapter in this guidebook takes its own unique approaches to embedding, showing myriad ways through which it can take place. Before presenting subject-specific guidance on embedding in the following chapters, this section provides generic considerations for embedding ESD in textbooks.

## 4.1

### Developing competency-based learning units

In recent years, a number of resource materials have been developed to provide guidance on integrating ESD and related education into school curricula (see Box 7), primarily to support curriculum developers, teacher educators and teachers in their implementation. Textbook authors may refer to these materials to check a catalogue of topics and methods that have been suggested to foster the knowledge, skills, dispositional and behavioural learning outcomes called for by ESD and related education.

Whereas calls for 21st century skills or transversal

competencies have increased in recent years (UNESCO, 2015c), competency-based learning is neither established in all national curricula nor applied equally in all subjects. Some countries focus on academic standards, while others concentrate on topics and learning objectives. Textbook authors will have to consider different lexicons and conventions in different educational systems. It is also important to note that the specification of ESD competencies is just one of many exercises towards more effective ESD implementation. It is critical to keep in mind that a competency-based unit will not be optimal until and unless teachers are properly trained in pedagogies conducive to deeper learning and adequately supported to create an environment that allows students to develop these competencies. Through an embedding approach, textbook authors can support teachers in their role as

#### Box 7

#### UNESCO guidance materials on ESD

Guidance materials on integrating ESD and related education into the school curriculum abound. Depending on the content they would like to create, textbook authors are encouraged to refer to resource materials developed by UNESCO to give generic ESD guidance (UNESCO, 2012a, 2012b, 2017a), generic global citizenship education guidance (2015a), technical guidance on integrating more specific topics such as disaster risk reduction (UNICEF and UNESCO, 2012) and sexuality education (UNESCO, 2009) into the school curriculum, or a teacher education course on climate change education (UNESCO, 2013). *Teaching Respect for All: Implementation Guide* (UNESCO, 2014b) calls for an embedding approach and provides examples of incorporating concepts of respect and anti-discrimination across subject areas, including mathematics. Helpful for the approach of developing competency-based learning units is *Education for the Sustainable Development Goals: Learning Objectives* (UNESCO, 2017a), which identifies ESD key competencies and outlines indicative learning objectives, topics and pedagogical approaches for each of the 17 SDGs.

learning facilitators by incorporating cues for creating such an environment. Textbooks can be an aid for teachers to implement ESD in their classrooms while teaching core academic coursework. The following sections present how textbook authors can select ESD themes, topics and issues (4.2) and encourage students not just to interpret the world but to shape it (4.3).

## 4.2 Selecting ESD themes, topics and issues

A broad ESD-related theme, a specific topic or an issue can be adopted as the focus for a curriculum unit within any subject, and many detailed examples are offered in the following chapters. ESD topics can be wide-ranging, from energy and water use and responsible consumption to poverty and its alleviation (see Box 1 for SDGs).

### Box 8

#### Criteria for selecting ESD topics

ESD topics should:

- Be meaningful and significant to the learner (relevant to their real life).
- Be issue based (problem oriented) and explore the possibilities of sustainable solutions.
- Be linked to one or more SDGs of the 2030 Agenda for Sustainable Development (see Box 1).
- Encourage to investigate and discuss the interconnectivity between local, national and global issues or development.
- Address the fundamental challenges and tensions facing humanity, giving particular attention to four challenges identified in UNESCO's (2015b) *Rethinking Education* report (pp. 21–26):
  - Ecological stress and unsustainable patterns of economic production and consumption.
  - Greater wealth but rising vulnerability and growing inequalities.
  - Growing interconnectedness but rising intolerance and violence.
  - Progress and challenges in fulfilling human rights.
- Be conducive to fostering selected ESD competencies (see Box 5), for example:
  - Invite a change of perspectives.
  - Foster the understanding and appreciation of socio-cultural diversity.

Broad themes that can serve as a cross-curriculum umbrella may focus on change, complexity, uncertainty or diversity. The term 'issue' is used to refer to any problem where there is significant disagreement about the appropriate solution among the people affected.

Some school subjects have already started to include ESD issues and topics, although the content

in mandatory curricula is usually structured in a systematic way around key concepts of academic disciplines. This can become a challenge for textbook authors and publishers, who wish to produce a new generation of textbooks that integrate ESD. They have to discover niches in the prescribed curriculum. Some curricula, however, are less rigid and allow for the implementation of ESD topics or a thematic approach (see the Mathematics chapter, section 3.4 and the Science chapter, section 3.1), which relates curriculum topics to each other and associates them with ESD issues. This approach allows textbook authors to emphasize the interconnectedness of socio-scientific issues and to explore the controversies and complexities of real-world situations. Box 8 lists some generic criteria that may be helpful in selecting ESD topics.

The chapters in this guidebook provide subject-specific guidance on how to select ESD topics and connect them to pedagogical approaches. As the examples in all four subject chapters discuss in detail how the integration of content and pedagogy can be achieved in textbooks, the following section briefly discusses considerations for including pedagogical insights in textbooks.

## 4.3 Making ESD issues 'matter' to students

Education traditionally equips students to understand and, at best, conceptualize problems but rarely to enact solutions. This suggests that textbook authors should provide ideas for structuring student inquiries into sustainability questions and issues. They should also encourage student participation by prompting learners to act on the results of their inquiries.

The aspirations captured in the 2030 Agenda for Sustainable Development represent broad aims and ideals that do not directly address the context in which education and social change take place. ESD principles will have to be translated into pedagogical practices that engage students in developing meaningful understandings and enduring dispositions. Teachers need to be encouraged and supported to connect the principles to their students' local place or community and lived experience, while also connecting to the respective influences of the 'global on the local' and the 'local on the global' (Stevenson, 2007).

The challenge for textbook authors is to create an environment that engages students intellectually and emotionally in sustainable development – to make sustainable development issues and topics 'matter' to students. This section includes advice that pertains to framing content as well as the use of language and visuals and writing style when embedding ESD in textbooks. ESD pedagogies prioritize thinking, valuing

and acting as fundamental to educational practice (Reid, 2002). As discussed earlier, ESD should occur through a range of student-centred and inquiry-based teaching and learning activities. When these activities are contextualized using real or authentic examples, critical thinking, problem solving and active student participation that emphasizes reflexivity, students have the opportunity to develop deep environmental, economic, social and political understandings and the capacity to enact positive individual and collective environmental and social change. Although thinking, valuing and acting are often intertwined, the three sub-sections that follow will elaborate on some key pedagogical strategies aimed at fostering (1) cognitive skills, (2) socio-emotional skills, attitudes or dispositions and (3) actions. Critical inquiry is central to all of these broad strategies, although it is discussed first. These strategies are not intended to be exhaustive but to be modified and added to as necessary.

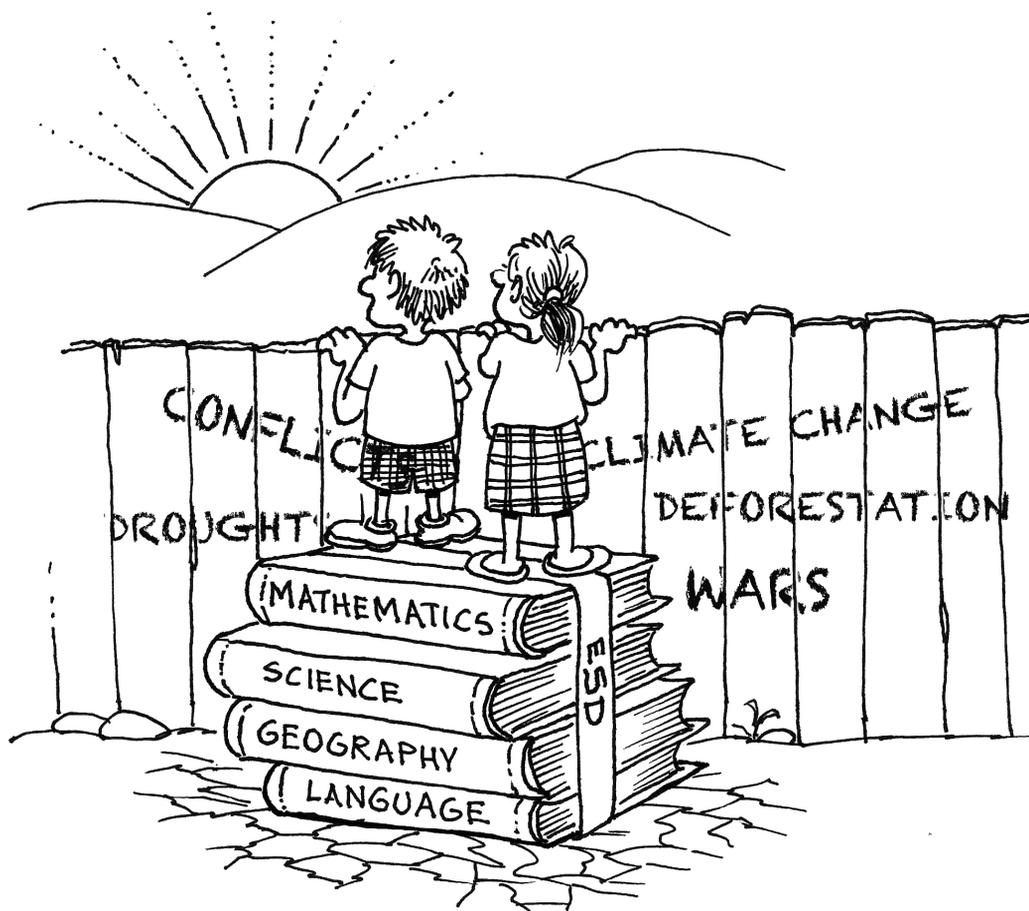
### Critical inquiry and systems thinking

One way to create an environment conducive to thinking is to write learning units that allow multiple and complex answers and engage students in critical inquiry. It is important to employ an authoring approach that is not top-down. It needs to allow students to think critically, to engage with the content and perceive knowledge as an ongoing process rather than something fixed in stone that cannot be challenged. Critical inquiry is the process of examining existing assumptions and deconstructing,

reconstructing and constructing knowledge. Inquiry, critical thinking and integration abilities<sup>11</sup> enable a student to identify a problem, propose solutions, find evidence for and against proposed solutions, and evaluate the solutions based on this evidence. Critical inquiry assists students to examine and challenge the status quo and deepen their critical understanding of the issues in the world around them.

Meaningful learning, as opposed to mechanistic absorption of information, can bring our complex world alive by making it clearer. Textbook authors can write content in a way that facilitates open-ended instruction, rather than steering students toward one 'right' answer. ESD 'entails more than simply knowing things about the environment, economics, or equity and social justice issues, but rather involves a willingness and ability to engage intellectually and personally with the tensions that are created by the interconnectedness of these systems' (Nolet, 2009, p. 421). Often the tensions and conflicts arising from different values and interests are missing from what is taught in school. It is important to engage students – appropriately for their age and development – in identifying, understanding and analyzing these conflicts and learning that debate and negotiation are a part of a democratic political process. By analyzing these conflicting interests at the individual, organizational and structural levels, and at geographical scales from local to global, students learn not only the root causes of sustainability issues but also what actions they can take to address them.

<sup>11</sup> See, for example, [www.schoolofthing.com](http://www.schoolofthing.com) for a broad range of resources for fostering deep understanding, inquiry and integration.



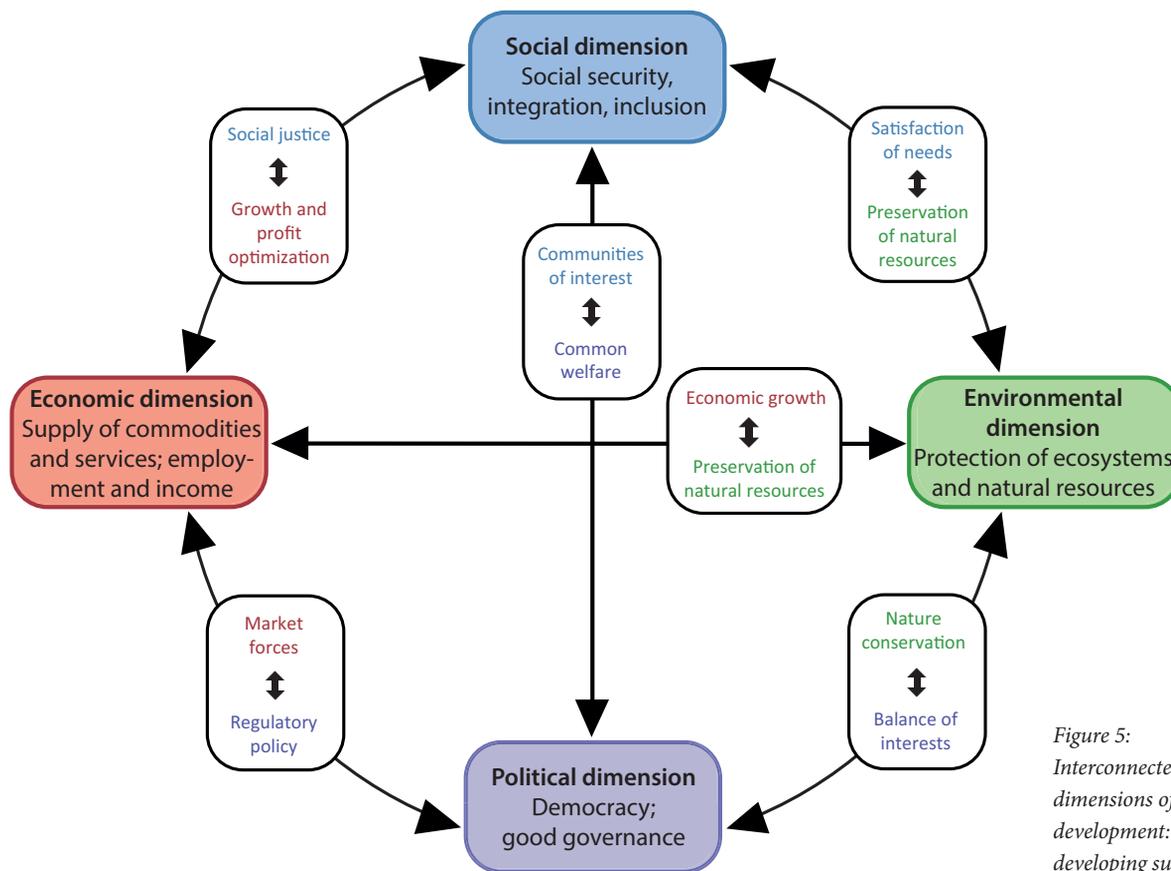


Figure 5:  
Interconnected  
dimensions of sustainable  
development: towards  
developing sustainable  
solutions

*Embedding ESD should take into account the challenge of changing the essentially anthropocentric understanding of the world, while reclaiming the intrinsic value of education as an experience that enhances each individual's capabilities and freedom*

Figure 5 can help students analyze these tensions and conflicts from a holistic perspective and cultivate their critical and systemic thinking abilities by taking into account the interconnected environmental, economic, social and political dimensions of sustainable development. The graphic is a representation of these dimensions that highlights the fundamental tensions between them. This kind of visual model can also be used in the classroom to help students understand and develop meaningful responses to sustainable development issues. The chosen issue can be analyzed by discussing the tensions and possible sustainable synergies between the four (coloured) development dimensions. For more advanced students, the model can be used to deal with the chosen issue from the individual to the global level.

Systems thinking is a useful approach to problem solving that is more effective than considering problems in isolation. Given the complexity of sustainable development, a model like this can only provide orientation. Figure 5 cannot, for example, describe the complexity of human dependence on the biosphere.

Scientific knowledge has been largely gained by isolating problems into components, but it has become apparent that many of the complex problems facing humanity require a more systemic approach. Embedding ESD should take into account the challenge of changing the essentially

anthropocentric understanding of the world that dominates many disciplines and much of the school curriculum. At the same time, it should rearticulate the humanistic agenda in education and reclaim the intrinsic value of education as an experience that enhances each individual's capabilities and freedom. While environmental science classes may try to develop in students a sense of the severity of the current ecological crisis and the importance of conservation practices in response, core subjects may continue to promote a utilitarian perception of the environment (the world in which we live) as a bank of resources for humans to use in the name of progress. This latter approach is counter to the purpose of fostering in students an environmental conscience and stewardship (see Kumar, 2017, and the Science chapter's Example 1 on forest communities and Example 4 on the impact of agricultural practices on bee populations, which consider how human relationships with fragile ecosystems may be approached by authors in core texts). Textbook authors can highlight the interconnectedness of biological, physical, social, economic, political and cultural phenomena and refer to the interdisciplinary treatment of issues from the holistic perspective of sustainable development. They can encourage teachers to go beyond the boundaries of their own subject matter or discipline and to consciously incorporate knowledge from other disciplines, while also establishing both the potential and limits of a single subject to address sustainability issues.

## Perspective taking and changing perspectives

One of the important tasks of education is to help students understand, respect and question values – their own, the values of the society in which they live and the values of others around the world. To address the tenacity of stereotypes and the inability to have genuine dialogues to overcome conflicts, first and foremost, it is critically important for textbook authors to ensure that the content they write is free from harmful gender, religious and other stereotypes (for general guidance on making textbook content inclusive, see UNESCO, 2017b). While many of the identified ESD competencies are linked to values (see Box 5), ESD is not about preaching ‘universal’ values to students as passive recipients.<sup>12</sup> Textbook authors should employ an approach that is not moralistic but allows students to encounter and engage with difference and diversity, to analyze different perspectives while reflecting on their own assumptions, perspectives and values.

Textbook authors can use pedagogic strategies, such as role-playing and simulations or story-telling and reflective writing, to provide an opportunity for students to cultivate empathy, that is, an in-depth understanding of another person’s perspective. In societies dealing with historical trauma, textbook authors could present discussions between people in which the processes of stereotyping, fearing and demonizing the other can be deconstructed and made more explicit to students. While cognitive and affective perspective-taking can be understood as an important component skill of empathy, what is needed is more than a fostering of tolerance towards and empathy for those who are different or an ‘openness’ to other perspectives. In our globalizing world, where students encounter diversity both virtually and in real life, the notion of ‘changing perspectives’ (see Box 5) is gaining significance (Gannon, 2002; Wettstädt and Asbrand, 2013). Going beyond dominant approaches to multiculturalism, which focus on fostering empathy with those who are discriminated against, a range of activities included in the resource guide *Changing Perspectives* (Gannon, 2002) challenges students and teachers to delve into stereotypes and prejudice and the situation of minority groups in their own society to confront their own prejudices and broaden their perspectives.<sup>13</sup> Some activities engage students and teachers in disagreement or conflict around issues they feel strongly about. They resonate with the ‘pedagogy of discomfort’, which involves disrupting deeply rooted understandings of how the world works (Boler, 1999).

Textbooks can be written in a way that enables teachers and students to leave their emotional comfort zones, to discover and acknowledge their own biases towards different cultures or their own culpability in ecological or social injustice. They can then come to realize that they can change an undesirable situation whereby they have contributed to other people’s pain or ecological damage. In an age-appropriate and culturally sensitive manner, learning units can evoke discomforting emotions – such as irritation, guilt, shame and anxiety – a valid entry point to examine and overcome biases and prejudices as well as to change unsustainable lifestyle choices. Nevertheless, it must also be noted that such ‘pedagogy of discomfort’ can be too uncomfortable, even for post-graduate students (Bryan, 2012), and may not be appropriate for younger students (Zembylas and McGlynn, 2012). This consideration is especially pertinent when addressing controversial issues that require students to acknowledge their own privilege and complicity in structures of inequality and injustice based on gender, class, race, ethnicity, geography, caste, sexuality, religion and more.

## Real-world connections

Reorientation of academic content towards ESD should ideally be accompanied by ‘real-life’ documents and more expressive language to allow students to connect with the material being taught. Textbook authors can include visual and textual representations that are attractive, diverse and powerful. Furthermore, authors are encouraged to suggest ideas for student-centred teaching and learning activities that allow students to awaken all their senses, make decisions and take actions that contribute to creating a sustainable society and ecosystem. For example, textbooks can include suggestions for linking subject content to opportunities to engage in community-based experiential and participatory learning through extra-curricular activities, collaboration with stakeholders outside of school, excursions and discussions with experts or on-the-ground projects that deal with sustainable development issues.

All of these activities can, in turn, be part of ‘project-based learning’, which has become one of the preferred pedagogic strategies in ESD. Project-based learning aims to go beyond the application of knowledge and skills to assigned tasks, expanding room for decision-making and responsibility on the part of students and building their sense of self-efficacy as active participants in a given project. Project-based learning can also be integrated with the activities of a ‘whole-school approach’ to ESD (see Box 9).

*To address the tenacity of stereotypes and the inability to have genuine dialogues to overcome conflicts, first and foremost, it is critically important for textbook authors to ensure that the content they write is free from harmful gender, religious and other stereotypes*

<sup>12</sup> There are widely accepted ‘universal’ values articulated in the *Earth Charter* (1992), the 2030 Agenda for Sustainable Development (United Nations, 2015) and other international documents. These core ‘non-negotiable’ values include: respect for biological and cultural diversity, democracy, environmental protection, eradication of poverty, gender equality, human rights and a culture of peace and non-violence, among others. For the list of international human rights instruments, see UNESCO (2017b), pp. 26–27.

<sup>13</sup> This resource guide was developed for Civic, Social and Political Education (a compulsory subject in the Junior Certificate course for the first three years of secondary education in Ireland) to ensure that Ireland becomes ‘a society where diversity is valued ... where interaction between diverse groups takes place and is underpinned by equality, human rights, mutual respect and understanding’ (Gannon, 2002, p. 5).

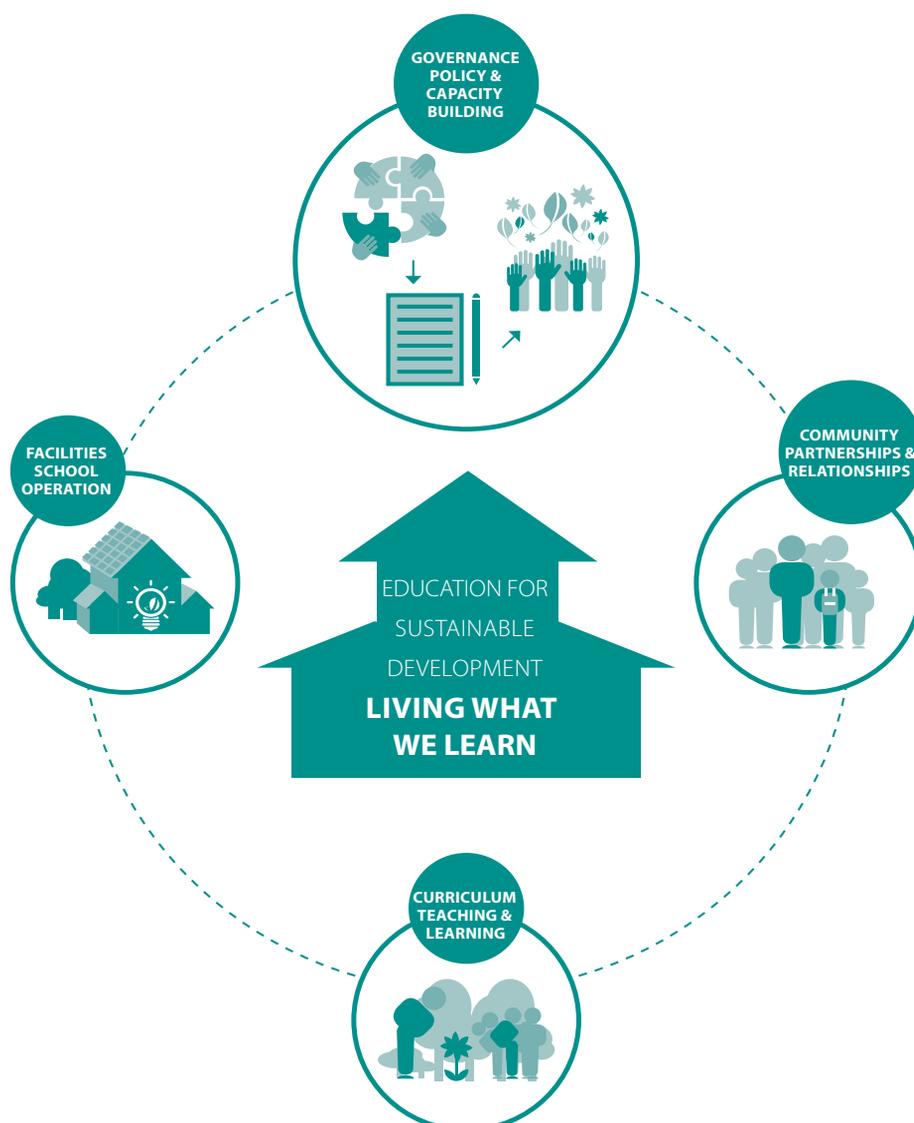
## Box 9

**Whole-school approach**

Formal education has an essential role to play in the transformation process called for by the 2030 Agenda for Sustainable Development. To empower students to become change agents, sustainable development should gradually become the value centre and common point of reference for all school subjects, structures and activities. It greatly contributes to student learning when schools and all their activities are seen as a microcosm of society that has to become sustainable. In common with other institutions, schools are facing challenges such as sustainable facility management, responsible use of resources, waste management, democratic participation, appreciation of socio-cultural diversity and inclusion. In many cases, school is the community and lifeworld closest to the students.

Apart from the cross-curricular coordination of various subjects and their alignment with sustainable development (see Box 6), the orientation of the whole school towards this principle should find ways into new textbooks. The whole-school approach gains its strength from a common focus and the coherence of its elements with the learning process in subjects. For example, the growing of vegetables in the school garden can be linked with biology and health education, the sustainable student enterprise with economics and school partnerships with language education and geography. Promoting whole-institution approaches is a priority action area of the Global Action Programme on ESD (2015), a follow-up framework of the UN Decade of ESD (UNESCO, 2014a).

*The whole-school approach gains its strength from a common focus and the coherence of its elements with the learning process in subjects.*



## 4.4

## Assessment in alignment with ESD

Assessment communicates to students what kind of work is valued. The subject chapters of this guidebook do not elaborate on assessment and much work still needs to be done to assess learning in the domains covered by SDG Target 4.7. This section, therefore, briefly discusses what kind of assessment is aligned with ESD. We suggest a focus on authentic assessment, which asks students to perform real-world tasks that demand the application of complex knowledge and skills to address a problem or issue – in this case, connected to sustainable development. Both teaching and assessment should aim for authentic performance, such as the construction of knowledge through reflective inquiry. This results in ways of thinking and acting that have value and meaning beyond success in school tests or exams (Newmann, Secada and Wehlage, 1995).

The pedagogical guidance given in the subject chapters is often linked to issue-based content and student-centred teaching and learning activities. Inquiry-based and action-oriented teaching-learning processes (see section 4.3) can be supported through different forms of assessment tasks that could be introduced into textbooks in connection with the tasks for a learning unit.

It is widely understood that although ESD is applicable across all school subjects, monitoring performance

and evaluating assessments may differ from subject to subject, and some disciplines may be able to address ESD more directly than others. The knowledge, skills, dispositional and behavioural learning outcomes called for by ESD and related education can be embedded in the general learning outcomes of a particular school subject. Assessments in alignment with ESD may include:

- Tasks that ask students to demonstrate the development of ESD competencies that include both written and non-written performance (essays, reports, debates, presentations, etc).
- Group activities that offer opportunities to apply ESD competencies to real-world situations or collaborations with external actors and organizations (local, national, international).
- Tasks that ask students explicitly to study and address the relationship between the subject and sustainable development.
- Role-playing activities that encourage affective learning and the development of empathy and respect (these could involve written work, videos, theatrical plays, etc).
- Peer review and self-assessments that ask students to monitor their learning and reflect critically on their progress as well as that of their peers.
- Assessment through interactive dialogue between the teacher and learner, aided by the use of rubrics or competency grids.<sup>14</sup>

<sup>14</sup> See the competency grids for sample units in eight subjects indicating the level of attainment of competencies in Schreiber and Siegel (2016).

## 5.0

## Outline of the guidebook

This chapter has offered an introduction to embedding ESD into textbooks, presenting the case for why this is important, necessary and beneficial, as well as explaining key pedagogical considerations. The main body of the guidebook is composed of four subject chapters:

MATHEMATICS

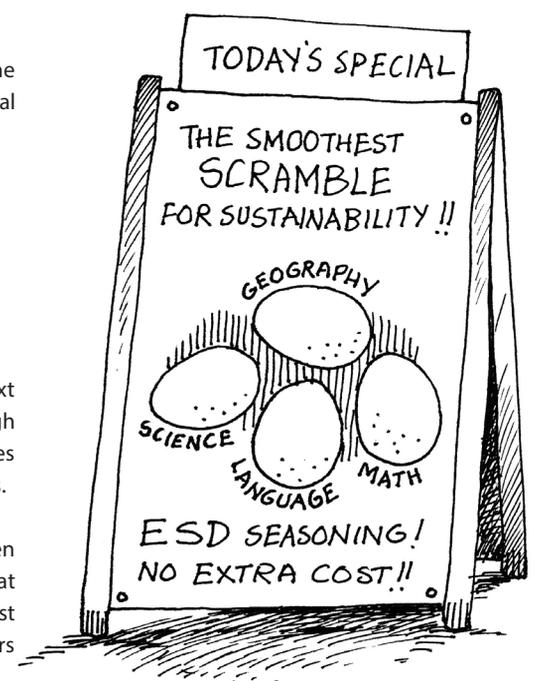
SCIENCE

GEOGRAPHY

LANGUAGE

It is important to keep in mind the interrelatedness of these subjects, especially in the context of 'issue-based' learning and the principles and competencies discussed above. Although each subject is independent in its own right and has a structure that reflects the specificities and requirements of the subject matter, there is a common thread across these chapters.

Each chapter begins by explaining how the particular subject contributes to ESD. It then expands on the tools and competencies for each subject by guiding the reader on what 'ingredients' and processes are needed to embed ESD in subject content. Finally, the last section of these chapters includes concrete examples of embedding, which textbook authors can replicate in their contexts or take inspiration from.



## 6.0

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‘ *Mathematical actions – counting, measuring and locating – indicate clear connections between people and their environments. Through this kind of mathematical activity, people design ways to meet their needs in efficient ways. This is a way of saying that mathematics is a tool for sustainable development* ’



*In all probability ... what do you think?*

# 2

## MATHEMATICS

1.0	<b>How can mathematics contribute to sustainable living?</b>	37
2.0	<b>Potential contributions of mathematics to ESD</b>	38
2.1	Mathematical processes	38
2.2	Generalization and abstraction	38
2.3	A tool for complex systems	39
2.4	Limitations	41
2.5	Beauty	42
3.0	<b>Tools and principles for ESD curriculum development</b>	43
3.1	Avoiding simplification	43
3.2	Word problems versus rich contexts	43
3.3	Critical thinking	45
3.4	Engagement with issues	46
3.5	Helpful resources	49
3.6	Guidelines for embedding ESD in mathematics textbooks	50
4.0	<b>Examples of embedding ESD in mathematics text</b>	52
4.1	Example 1: Measurement and comparison	52
4.2	Example 2: Shape and space	56
4.3	Example 3: Algebra	58
4.4	Example 4: Modelling and prediction	60
4.5	Example 5: Representation	62
5.0	<b>References</b>	63

## 1.0

# How can **mathematics** contribute to sustainable living?

**PEOPLE WHO LOVE** mathematics celebrate its beauty and utility. However, many others fear mathematics and some even say they hate it. The strong feelings mathematics can arouse stem from people's experiences of the subject, especially how they were taught it in school. The teaching of mathematics makes a strong impact – it determines what people consider mathematics to be and it affects how they use (or whether they choose to ignore) its tools. Mathematics textbooks play a strong role in the way students think about mathematics and how it connects to their community concerns. Mathematics is a necessary part of basic literacy in the 21st century.

This chapter describes the potential of mathematics for contributing to sustainable living, peace and global citizenship (see the Introductory chapter for elaboration on sustainable development, which is a term intended to include peace and global citizenship). It outlines how authors of mathematics textbooks and related resources can design them to support the development of mathematics' potential in students while also orienting students to sustainable development concerns. To embed education for sustainable development (ESD) into mathematics textbooks in this way, it is necessary to ensure students see mathematics as a way of thinking developed by humans to address their concerns in particular contexts. It is important to recognize that mathematical tools are developed to address local challenges or concerns. Mathematical tools that are developed in response to particular concerns may be applied to challenges in different contexts, although such applications may have limitations.



This chapter encourages the development of mathematics textbooks that promote the Sustainable Development Goals (SDGs). It considers human challenges addressed by mathematics, and thus describes how mathematics is a human activity that can support aspirations for sustainable development. Next, the chapter outlines advice and support for textbook authors with an interest in ESD. The chapter closes with examples of text and discusses how these examples connect to the guidance given in this chapter. Strong connections to particular SDGs will be identified in brackets with reference to the specific SDGs developed by the United Nations, for example, this chapter is intended as a resource for partnerships for ESD (SDG 17). Similarly, strong connections to the ESD competencies outlined in the Introductory chapter are referred to in brackets. Everything in the chapter connects in multiple ways to ESD competencies and SDGs, but only the strong connections are identified to keep these orienting principles and goals in mind.

## 2.0

## Potential contributions of mathematics to ESD

## 2.1

### Mathematical processes

Mathematics can be understood (philosophized) in varying ways. With an interest in embedding ESD, it is important to think of mathematics as a human activity, as a way of addressing challenges in particular human contexts. With more ‘formalist’ views of mathematics, it would be difficult to embed ESD in textbooks because ESD expects students to develop knowledge and skill in relationship with their communities and environment. Mathematician Reuben Hersh describes well how mathematics is, in fact, a human activity (Hersh, 1997).

Understanding mathematics as a human activity makes it possible to think about how it can either support or undermine sustainable development. Alan Bishop (1988) described six categories of human activity for examining cultural practices to identify mathematics. Mathematics is counting, measuring and locating. When people design, explain or play with counting, measuring or locating, they are doing mathematics. For millennia, people in every culture have described objects in terms of their quantities, their sizes and their location. These mathematical actions – counting, measuring and locating – indicate clear connections between people and their environments. For example, people often count days and keep records of events to predict a good time to plant crops, to organize gatherings, etc. Calendars are used for this. It is likewise a common practice to measure parts of a person’s body to make clothing that fits. As an example of location (geometry) practices, people identify landmarks and use words and numbers in relation to these landmarks to remember how to find a specific place or direct others to that place. With this kind of mathematical activity, people are designing ways to meet their needs in efficient ways. This is a way of saying that mathematics is a tool for sustainable development.

*Understanding mathematics as a human activity makes it possible to think about how it can either support or undermine sustainable development*

## 2.2

### Generalization and abstraction

Mathematics also includes generalized tools that are used in these endeavours but these tools are not as clearly associated with their environments. For example, we may notice that three mangos grouped with five similar mangos forms a group of eight mangos. Because this is true for other kinds of objects as well, we say  $3 + 5 = 8$ . Always. The expression  $3 + 5 = 8$  is an abstraction because it is not connected to any particular context. For an example involving measurement and location, people have noticed that a triangle with sides measuring 3, 4, and 5 always has a right angle, no matter what unit of measure is used. This generalization has been used for millennia in the construction of buildings that meet human needs with efficiency.

Most uses of applied mathematics draw on generalizations. For example, when designating boundaries for elections, populations are counted in regions but the counting is complex because people are ageing (coming of age to vote), dying and relocating, and the numbers are high. To deal with this complexity, designers use algorithms for computation and identify patterns to make predictions of future populations. These computational tools and models for describing pattern are abstractions. The same process involves decisions about shape and space because the designers need to construct boundaries that make sense to people. For this, they draw on geometric objects that are well known, for example, straight lines and smooth curves, all of which are abstractions.

Abstractions like this are powerful tools for the deeper evaluation of human challenges because they allow us to make predictions and to design physical and conceptual structures that meet our needs and desires. The sustainable development framework developed by the United Nations balances immediate needs with long-term and societal needs. In other words, an individual’s need for clean water (SDGs 6 and 14), healthy food (SDGs 2, 3, 14 and 15) and meaningful work (SDG 8) is ideally balanced with others’ current needs for these things (SDGs 1, 2, 4, 5 and 10), as well as the long-term availability of resources to meet people’s needs in the future (i.e. sustainability). Mathematics can help us to negotiate such balances, although such endeavours are never straightforward.

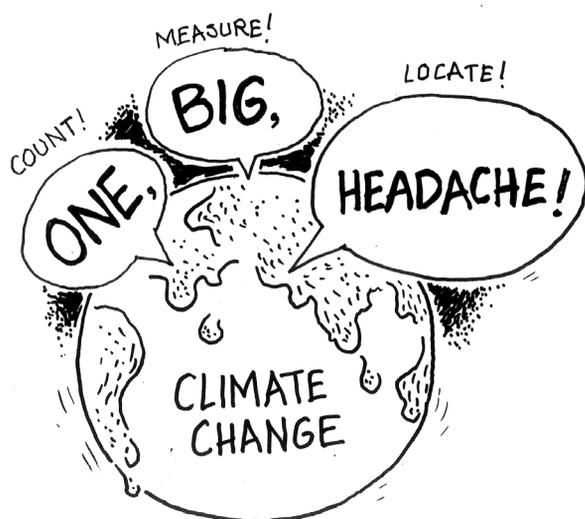




Figure 1: Managing conflicting goals with mathematics

### 2.3

## A tool for complex systems

To balance conflicting needs (see Figure 1), decision-makers consider various measures that indicate the attainment of identified goals and assign numeric values to things that are not straightforward to measure. These values can be weighted according to the value assigned to each goal. These measured and weighted indicators can be used in various policy scenarios that may be imagined to identify an optimum decision. Of course, this all depends on the quality of the decision-makers' choices about what to measure and which measures to value the most, and it depends on the quality of the mathematical model for predicting results that connect with prospective decisions. All these decisions may make such endeavours seem rather arbitrary, but alternative approaches to such decisions are no less arbitrary.

It is common practice for national and jurisdictional leaders to evaluate decisions based on GDP (gross domestic product) – the idea is that when material

wealth is maximized, people prosper. It is worth considering alternatives because, for example, GDP can rise even when the poorest people remain impoverished. Furthermore, there are other concerns in addition to material wealth. Some alternative measures for decision-making include:

- Developing one's own measure that foregrounds certain concerns, for example, one could instead measure the wealth of the poorest quartile, access to meaningful work, quality food, etc.
- The Gini index has been developed to measure the distribution of wealth in a nation or region (<http://hdr.undp.org/en/content/income-gini-coefficient>).
- The country of Bhutan requires policy initiatives to be justified on the basis of gross national happiness instead of GDP (<http://www.grossnationalhappiness.com>).

*Mathematical actions – counting, measuring and locating – indicate clear connections between people and their environments. Through this kind of mathematical activity, people design ways to meet their needs in efficient ways. This is a way of saying that mathematics is a tool for sustainable development*

- The United Nations tries to measure a range of important indicators in its reporting on developments in nations. The organization has developed a resource on Indicators of Sustainable Development and relevant guidelines and methodologies (<http://www.un.org/esa/sustdev/natlinfo/indicators/guidelines.pdf>). Further to this, the *Inclusive Wealth Report* (UNU-IHDP and UNEP, 2014) gives a comprehensive analysis of a range of indicators, including a discussion about how these are interrelated, in its comparison of nations. It includes the disaggregation of wealth data on the basis of racial or ethnic categories, gender, religion, age and geography. This data is useful for social movements that promote the elimination of disparities and inequalities (<http://mgiep.unesco.org/wp-content/uploads/2014/12/IWR2014-WEB.pdf>).

*Mathematics provides tools for decision making. We can use demographic distinctions to count and compare populations, which allows us to identify inequities and thus enable the design of programmes to address them*

The identification of measures, attribution of values and design of predictive models makes discussion of these important human decisions explicit. This kind of discussion is necessary to enable engaged citizens to make good decisions both locally and globally. Ideally, the involvement of a wide base of citizens in such discussion would support the strongest decisions. For this to happen, students need to learn to use mathematics in these potentially powerful and compassionate ways. Not all children and students become mathematicians but we have to prepare them to use mathematics in the world.

Mathematics also provides tools for decision-making at a local level or focused on particular issues. For example, we can use demographic distinctions such as age, gender, ethnicity, immigration/refugee status, religion, sexual identity or socio-economic categories to count and compare populations of people in prison, executive positions, government leadership, teaching positions, etc. These comparisons allow us to identify inequities and thus enable the design of programmes to address the inequities. Typically, programmes that aim to redress inequities rely on mathematical tools in their implementation as well.

Number systems make the precise and accurate communication of quantities possible. (It should be noted that precision and accuracy are often taken as relatively synonymous but they have distinct and clear meanings in science.) As far as we know, every culture has developed language to describe number, including both precise number words and words that describe broader categories of quantity, such as few, some, many or most. Symbolic systems make it possible to work with quantities that defy human understanding. A strong example of this is place-value notation, which allows accurate and precise calculations far beyond amounts we can visualize (beyond our abilities to visualize at a large or microscopic scale). Language for precision goes beyond counting numbers to include partial amounts, represented by fractions and decimals,



and extending into more imaginary values, such as negative and complex numbers. Similarly, cultures have developed precise and imprecise standards for measuring objects. For example, a stretch of garment may be measured with hand spans, which vary slightly from one measurement to another but such measurements can be made without precise tools. Or the same garment may be measured with centimetres, which are based on an accepted standard recognized across borders, providing a basis for accuracy because the measures would not vary significantly. These systems – number and operation systems, symbols to represent them and measuring systems – are examples of human ingenuity addressing community needs and are, therefore, important to people who want mathematics to be seen as a way of addressing sustainable development values.

These powerful advances in mathematics allow humans to communicate with precision and accuracy, without ambiguity and with relative brevity. There are significant social implications for such clear communication. Justice and peace (SDG 16) require the possibility of trade and agreements with clear standards and measurements. For example, the price charged for wheat should not depend on the customer's skin colour or their relationship with the vendor (SDGs 5 and 10). With standard measures of mass and grain quality, it is possible to enforce the avoidance of discrimination in grain sales. For an example at a global scale, if countries are to agree on greenhouse gas emission reductions (SDGs 13–15), they need precise ways of measuring the time spans involved as well as the quantities and qualities of those emissions.

Proof and justification are often thought of as important reasons for learning mathematics. In the social situations described above – trade, treaties and other agreements – the need for proof and justification becomes very clear. People must justify their adherence to standards. They do so using the number and measurement systems described above, and they also use an approach to reasoning associated with mathematical proof – the expectation that each statement is justified. History tells us that quantification is associated with the development of democracies and other forms of community responsibility (Porter, 1995): when decision-makers are not identified through heredity or connection to deities, they must prove that their decisions are made in the interests of the collective good. Mathematics gives citizens the tools to obtain this kind of proof.

Human aspirations, such as reducing greenhouse gas emissions or exploiting a natural resource (an aspiration that often conflicts with reduced emissions), are typically described with mathematical notation with the goal of engineering an optimal result (ESD competency – facing the future). Such ‘mathematical modelling’ allows people to play with different structures and designs to maximize whatever they aspire to – efficiency, safety, biodiversity, predictability, etc. For example, when countries set emissions targets, their specialists use mathematical models to predict the kind of energy efficiencies that will become possible, the level of public support for such structural change, the impact on economies and more. All these factors are interconnected, which makes this a complex system (ESD competency – dealing with systems). But mathematical models are used on local scales as well. For example, farmers reduce waste and maximize their profits if they can successfully predict how much corn they will sell on market day. With accurate modelling, they can plant, pick and transport the ideal amounts of corn.

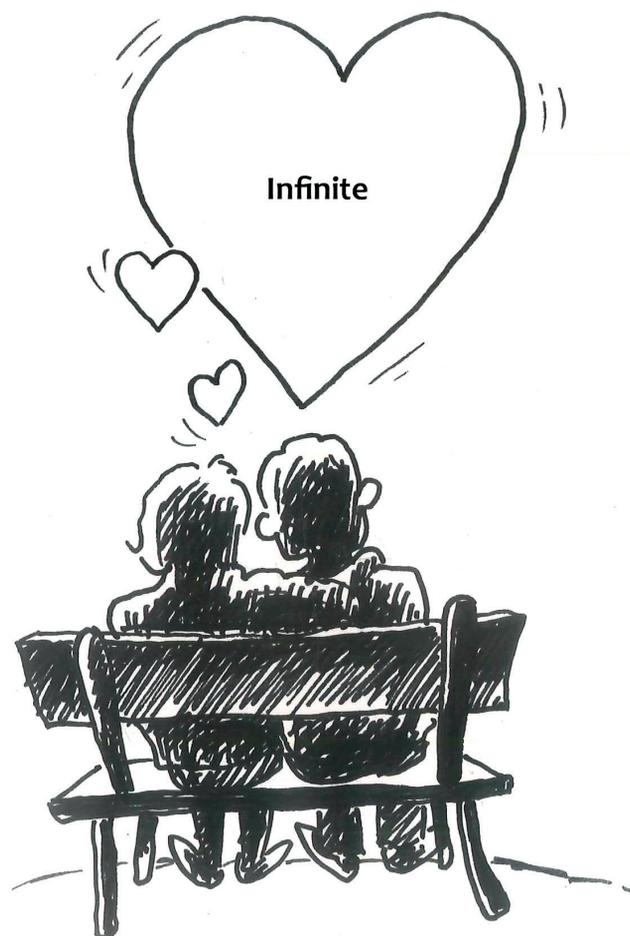
## 2.4

### Limitations

Any tool has limitations. For example, although it may be possible to quantify and thus measure aspects of love, fear, pain, hunger and other realities of human experience, it is wise to question the appropriateness of applying mathematical tools in any given situation. Furthermore, even if mathematical tools are deemed appropriate, it is necessary to remember that there are risks in using any tool. For example, mathematical tools are used to design technologies of violence – bombs, eugenics programmes (in which discrimination is explicitly related to measurement of human characteristics, such as intelligence, skin colour), etc. Even when people aim to do good with their mathematics, there are risks. It is worth remembering that politicians who have advocated bombings and eugenics programmes often seemed to think they were doing the right thing. It is worth

reflecting on our own conception of good and how it might have unintended negative implications.

As we move conceptually and physically from local and specific contexts, we pay attention to certain aspects and lose connection to others. Abstraction is part of this process and is an important part of mathematics. For example, farmers know a lot about the needs and capabilities of their cattle. Mathematical tools make it possible for farmers to scale up their farming to increase productivity and efficiency (SDG 2) which, in turn, causes them to lose their connection to the cattle. The trade in livestock and beef is a step further removed from the cattle, and investment specialists are even more distant. People who have never touched a live cow or bull are making decisions about cattle – decisions that affect the quality of the lives of the cattle and, in turn, the qualities of the meat and milk consumed by humans (SDG 3). These decisions affect who lives and who dies (SDG 10). The power of large-scale decisions made on the basis of numeric data must be balanced against the danger of decision-makers not understanding the environments they are controlling. We need to be careful about making claims of progress and development because sometimes steps that appear to improve lives in the short term have negative consequences that we might not predict.



## 2.5

**Beauty**

Mathematics as described above – including its language, notation and operations – is often seen as an important part of humanity's cultural achievement. In some ways it is a cross-cultural achievement because there are mathematical ideas and procedures that are shared across cultures. Yet there are unique mathematical ideas that address local cultures and contexts as well. For example, a boat-building family may develop unique procedures for measuring and cutting wood in a way that responds to the particular tree characteristics of their region. These unique forms of mathematics are also significant aspects of cultural achievement.

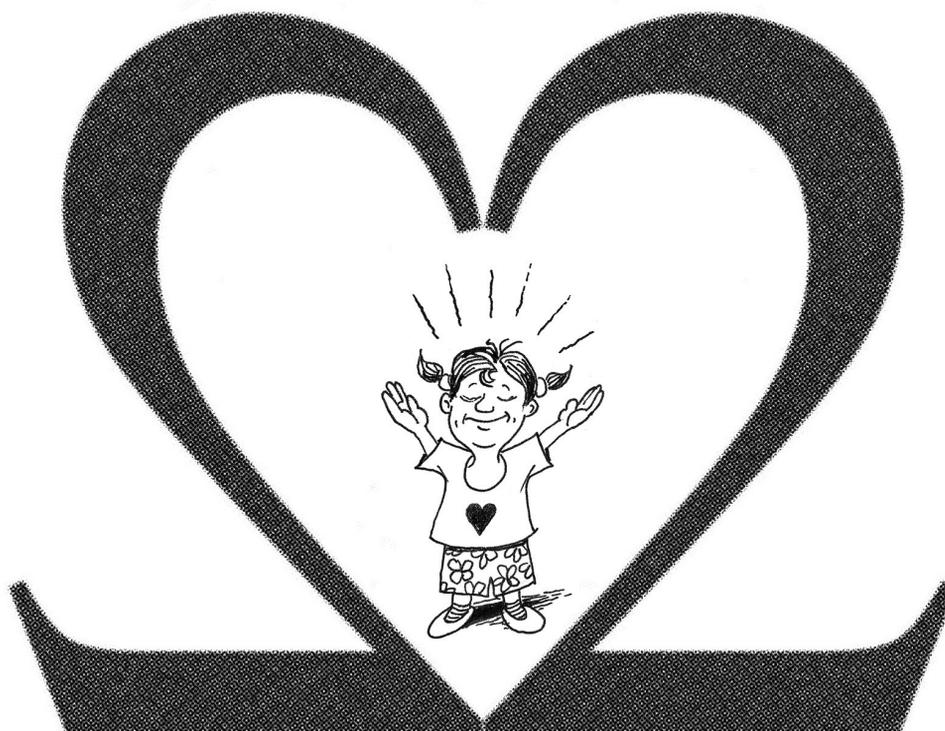
*Mathematics opens our eyes to symmetry and patterns that have aesthetic value beyond their practical aspects*

Considering these cultural achievements – in both cross-cultural and more culturally specific situations – mathematics is worth studying in a similar way to the arts. There is beauty in this human endeavour and appreciation of this beauty may help us respect the needs of people who are different from us (SDGs 10 and 16). Mathematics opens our eyes to symmetry and patterns that have aesthetic value beyond the practical aspects described above. These aesthetics may be appreciated even with a formalist view of mathematics in which the human role is not acknowledged. However, identifying the human role in these aesthetics makes mathematics an even more powerful force for peace. Many educators claim that the inclusion of aesthetics in education

increases harmony – when people stand beside each other to enjoy something beautiful, they become as one through the shared experience.

While peace and harmony are themselves a goal for sustainable development (SDG 16), conflict on a small or large scale (war, for example) endangers all the other goals for sustainability identified by the United Nations. War destroys environments. Any level of conflict undermines equality and some people's access to safe food, clean water and meaningful employment.

For a society with engaged citizens, it is very important that every child learns basic mathematics and is given the opportunity to learn more advanced mathematics (SDG 4). Mathematics gives people power to trump status with reason. It allows humans to organize themselves to trade fairly in local and global economies. By giving us comparison tools (statistics, for instance), it can be used to convince people of injustices and prejudices and to measure the effects of actions to address these issues. If children are taught that mathematics has only one correct approach in any situation, and they are not taught to reason with mathematics, others who are mathematically savvy will be able to convince the public of ideas that may be selfish or otherwise dangerous.



## 3.0

## Tools and principles for ESD curriculum development

This section focuses on the kinds of mathematics-based classroom activity that can contribute to peace and sustainability. In particular, it gives suggestions and guidance to mathematics textbook authors who wish to support ESD.

## 3.1

### Avoiding simplification

It is important to support the development of basic skills that students can then use for more complex actions. Necessary basic skills include those from other disciplines – most notably language skills relating to oral and written communication. The necessary skills also include basic mathematics, such as counting, measuring, addition, pattern recognition, graphing, etc. For example, it is important for children to be able to add and subtract numbers in order to work together to survey their school population's views on a community issue.

Although it is important to learn basic skills, educators often use this as an excuse for teaching mathematics only in its abstraction or with over-simplified contexts. This approach develops the idea that there is only one right answer to any question involving mathematics and that context does not matter. By contrast, ESD favours engagement with community issues. Mathematician Johan Galtung has written extensively about peace and remarks on the inadequacies of stereotypical mathematical thinking:

mathematics disciplines us into a particular mode of thought highly compatible with black-white thinking and polarization in personal, social and world spaces. The either-or character of mathematical thought makes it an exciting game: but as a model for a highly dialectic human, social and world reality it is far from adequate. (Galtung, 1990, p. 301)

For an example of abstracted mathematics, students are often taught to add numbers using blocks or simple diagrams. After learning what addition means, they complete exercises to practise the skills, and eventually apply this skill to contexts that suggest one right answer. However, addition and even counting, which is fundamental to addition, are not always so straightforward in real life. An important aspect of ESD is to connect all learning with students' contexts.

For example, if one counts the number of voters in two communities, the sum would have only one answer but there may be questions about who counts as a voter. This kind of question has obvious interdisciplinary potential. This interdisciplinarity does not water down the mathematics. It makes

the mathematics more meaningful by connecting the mathematical ideas to students' experiences – structuring their play, helping with cooking, living in certain conditions, hearing their family members talk about concerns, etc. For another example, if a textbook asks students to find the ratio of students to teachers in their school, they would have to count the students in the school and the teachers. They could add the number of children in a mathematics class, the number in a language arts class, and so on, but they would have to be careful to not count the same child twice or to miss absent children. Furthermore, counting the teachers is complicated because decisions would be necessary about who counts as a teacher. Does the head teacher or principal count, for example, or an education assistant?

The mathematics pedagogy pattern of starting with an example that explains a concept and practising with abstract exercises is common even in high-level mathematics classes. Because this approach uses relatively simplistic scenarios, and because the pattern repeats through a child's education, it is no surprise that a common view of mathematics is that there is only one correct answer. If mathematics is to support engaged citizenship and develop an understanding of the complex systems related to sustainability (ESD competency – dealing with systems), then it is important to use real and complex contexts for the teaching of mathematics at every level. The rest of this section describes how this can be supported by mathematics textbooks.

## 3.2

### Word problems versus rich contexts

Typical mathematics textbooks feature exercises, example problems and investigations. The exercises usually involve practising a skill, either in abstract form or in application to a context – a 'word problem'. The examples are usually tasks<sup>1</sup> similar to the ones given in the exercises but with worked-out solutions. Investigations are more open ended in that methods for addressing the problem successfully could vary and no obvious method is available. Perhaps the most obvious way to embed ESD outcomes in mathematics

*If mathematics is to support engaged citizenship and develop an understanding of the complex systems related to sustainability, then students need to work with real and complex contexts at every level*

<sup>1</sup> Mathematics textbooks are typically designed to provide information and prompts for action. Prompts for action are usually called mathematics questions but they are not always questions. Sometimes they are instructions. So this chapter will sometimes call them mathematical tasks.

resources would be to replace the word-problem contexts in exercises with contexts that relate to these concerns. These replacements could be done in examples, exercises or investigations. However, this kind of replacement may not do justice to complex situations described in the word problems, as explained below.

Let us consider universal principles for sustainability in relation to mathematics problems in learning resources. First, by definition, systems thinking places any problem in complex interaction with other problems and contexts. This relates to the ESD competencies identified in the Introductory chapter – dealing with systems and solving issues/problems/conflicts. Most mathematical word problems do the opposite of promoting systems thinking. This is because they simplify contexts and encourage students to ignore even some of the aspects mentioned in the simplified scenario.

For example, if the question asks how many fence posts are needed to enclose a rectangular field with given dimensions, students are typically discouraged from thinking about real fields and real fence posts. The posts are to be thought of as points (having no width themselves). The fence is to follow exactly the outside boundary of the property, although real fences usually give some space outside the fence before a roadway, for example. The question is not really about fence posts at all. The context is a throwaway one (Gerofsky, 1996). In this way, it would not be beneficial to replace such contexts with deep social concerns because we do not want to train children to ignore those social concerns. We do not want children to see the social issues as throwaway contexts. We do want school mathematics to address social issues but to do so in meaningful ways.

One approach to this typical characteristic of word-problem thinking would be to identify the word-problem contexts as simplified and to include questions that ask students to identify factors that would have to be considered in the real situation. This kind of question would also help students understand how mathematics is an imperfect but useful tool for addressing problems. A more powerful approach is to use problems that engage with social and environmental issues in more complex ways.

An even deeper way of introducing systems thinking is to replace the orienting expectations in a textbook. Instead of structuring the book around simplistic concepts, such as addition or fractions, the books could be structured around complex issues, such as organizing and sharing. Many mathematics textbooks are structured around procedures that are usually curriculum outcomes. For example, a

lesson might introduce fractions, followed by other lessons on equivalent fractions, comparing fractions, addition and subtraction of fractions and, perhaps, multiplying and dividing fractions, in which case the procedure is foregrounded even if some of the exercises or examples have social or environmental concerns as contexts.

An alternative textbook structure could be arranged around fundamental processes. If the textbook is structured around processes – such as organizing and comparing, modelling and predicting, measuring, representing and developing procedures – then it will be important to emphasize with each context how people are using the process to address the concerns in the context. A second alternative to the simplistic procedural orientation would be to organize the textbook around contexts. Section 3.4 below gives more guidance on this. Such an approach would require the contexts to be developed carefully to ensure coverage of the whole curriculum (assuming that it is a traditional curriculum, oriented around procedures).

*A deep way to introduce systems thinking is to organize textbooks around complex issues rather than simplistic concepts*

## Textbook structures

### Oriented around procedures

This is the most traditional textbook structure. It foregrounds abstraction and risks students seeing ESD contexts as throwaway concerns in word problems. However, ESD contexts may be effective in the hands of an ESD-minded teacher.

### Oriented around fundamental processes

This approach foregrounds human approaches to addressing problems and challenges, and highlights mathematical disciplinary practices (organizing, comparing, modelling, predicting, measuring, representing, designing algorithms, generalizing, etc). ESD-context problems would be seen in the light of these processes.

### Oriented around contexts

This approach foregrounds community and environmental concerns and would feature text that describes mathematical processes and procedures as arising out of such concerns.

## 3.3

## Critical thinking

It is a universal principle of ESD to develop critical thinking. Mathematics is a strong tool for identifying injustice, especially systemic injustices. For example, usually one does not need mathematics to identify racism in a particular interaction because it is identifiable in the language and actions of the people involved. However, we can use mathematics to chart patterns of interaction, which make it possible to identify racism in the system. As an example of systemic racism, one minority person in prison is not an indication of racism but a disproportionate number of minority prisoners can point to a system problem (see Table 1).

Systemic problems exist in every country. These problems may reflect issues in the justice system, access to education, access to safe and healthy food and water, or any number of things. This chart exemplifies systemic problems in the USA. The mathematics of the comparison is relatively straightforward. Considering the relationships among the reasons for the disparity involves more advanced mathematics and community knowledge. With or without that deeper knowledge, the mathematics makes it clear that there is a problem. Deeper knowledge of the situations and of mathematics can help people understand the problem.

Race/ethnicity	% of US population	% of US incarcerated population	National incarceration rate (per 100,000 people)
White (non-Hispanic)	64	39	450
Hispanic	16	19	831
Black	13	40	2,306

Table 1: US incarceration rates by race in 2010

Source: [www.prisonpolicy.org/reports/rates.html](http://www.prisonpolicy.org/reports/rates.html)

Maths resources can prompt students to compare proportions along race, gender, socio-economic or other lines in such things as wealth distribution, access to education, taxation, etc. For example, Eric Gutstein (2009) described how he had a class compare the demographics of juries to expose injustices. Ideally, these prompts for action would engage students in mapping the characteristics of their own community and thus engage critically with its problems and challenges. The students' participation (ESD competency – participating and collaborating) would show how mathematics is relevant to real problems in their communities and would enable students to understand complex mathematics because it relates to situations they know well. Another possibility is to engage in mathematics done within social movements. A textbook may ask students to verify the mathematical and statistical claims made by social or other organizations, or to engage in collective data-gathering to track phenomena across contexts.

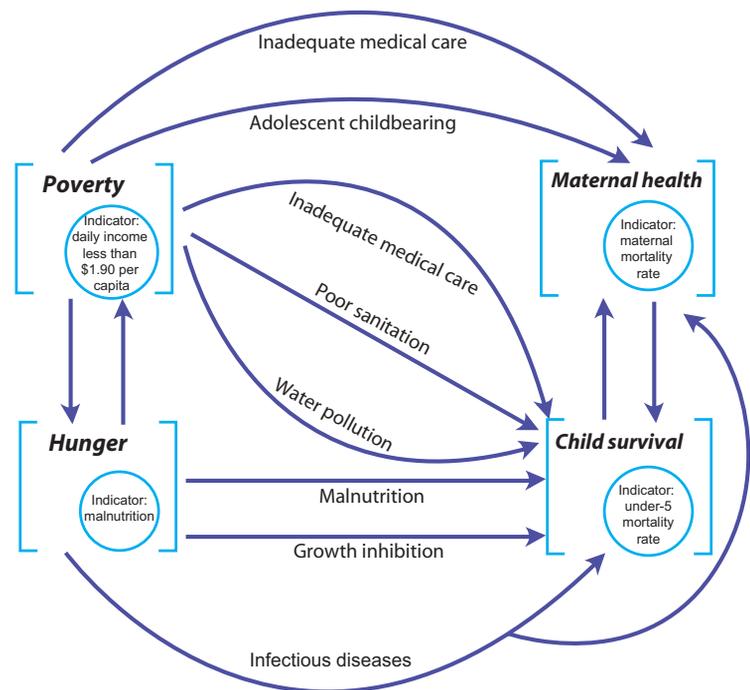


Figure 2: This diagram, developed by Antonius Warmeling, aims to capture the complex interrelationships among poverty, hunger and maternal and child mortality. Statistics on each of these phenomena may be considered in any given context or in comparison across contexts. Relationships among these statistics would require mathematics ranging from simple comparison with basic operations to dynamic system modelling.

Critical engagement, as described above, requires collaborative classroom environments. Real community problems are by nature complex, which means that students will be making choices about what to count or measure and what to compare. Different students will make different choices and so will benefit from comparing their approaches, which will require further mathematical work. When they collaborate in this way, they will understand better why multiple points of view are necessary for addressing problems (ESD competency – thinking and acting inclusively) and their discussion about points of view is likely to help them understand even their own choices and the mathematics they used. Collaboration also supports the development of student agency, that is, their sense that they can make choices about what to do and how to do it. It is important for students to develop agency so they can be engaged citizens. In other words, once students start to use mathematics in school to make sense of their world, they will gain the confidence to do this beyond school.

The interconnections between mathematics and community concerns are described in some detail by Eric Gutstein (2007). He uses three words beginning with the letter C – community, critical and classical – to help us remember what sort of knowledge should be developed for mathematics oriented around ESD. Community knowledge refers to things students already know. Students bring much knowledge to school, including knowledge of the cultures with

which they identify and about local features and interactions. Unfortunately, schools too often ignore this knowledge. Classical knowledge refers to the things that schools typically foreground, including mathematical abstract, conceptual and procedural knowledge. Critical knowledge refers to awareness of socio-political conditions. This may well be the knowledge that is most rare in schools.

3.4

### Engagement with issues

We encourage textbook authors to be first and foremost practitioners of the ESD competencies outlined in the Introductory chapter (see Box 5). This is best done to support engagement with the issues of one’s own community as well as those of others. This engagement should be supplemented with reflection on mathematics’ role in forming issues and challenges. This may include its fundamental role in structuring scientific and technological approaches to community challenges.

For example, when considering the way mathematics might be used to address disaster relief or avoidance, it is worth asking whether mathematics and the technology it supported brought a disaster upon a community. Example 4 in section 4.4 below features mathematics that analyzes aspects of land, sea and air in relation to a typhoon disaster. It would be wrong to blame this particular typhoon on any particular human action but we know that unpredictable and wild weather is increasing as a result of human technologies that have spurred on climate change.

In order to embed ESD effectively, a textbook author should:

- Observe and analyze issues and challenges in a community.
- Research to understand the complex systems at play and to identify reliable data that can represent some of the factors at play.
- Reflect on the larger context and the role of mathematics (and also science and technology because they rely on mathematics) in forming the issues and challenges.
- Identify the mathematics involved in this engagement with community issues and cross-reference this with the curriculum expectations/ outcomes that need to be addressed in the materials being developed.

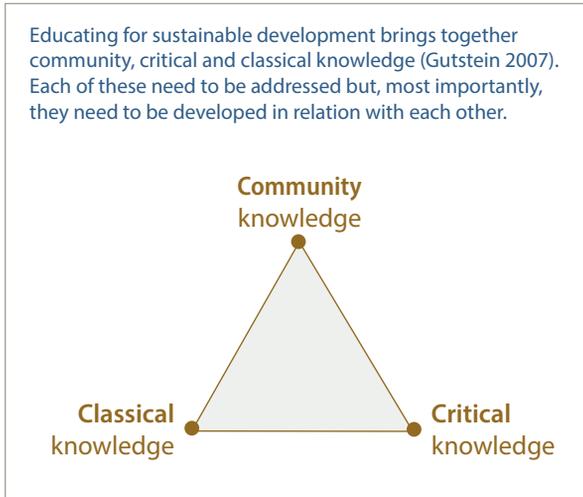
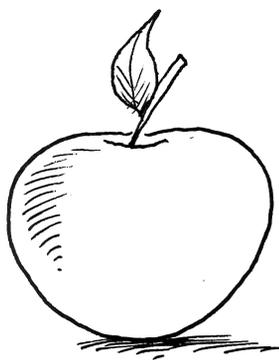
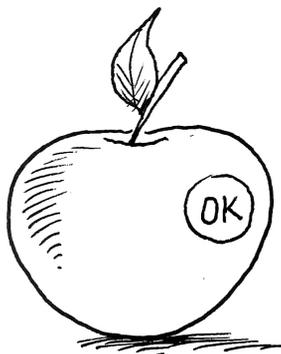


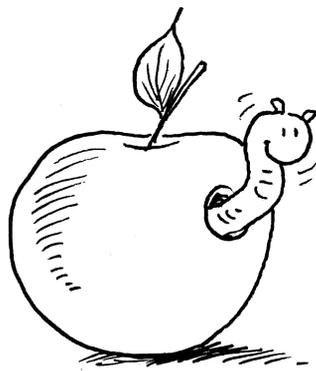
Figure 3: Integrated knowledge systems



COMMUNITY KNOWLEDGE



CLASSICAL KNOWLEDGE



CRITICAL KNOWLEDGE

The chart opposite suggests possible starting points for investigating social and sustainability issues with mathematics. Clearly, there would be many other possible starting points and sample topics for each starting point. For example, a UNESCO publication called *Teaching Respect for All: Implementation Guide* (UNESCO, 2014) has a list of contexts ripe for teaching respect to all (pp. 164–165). The chart opposite focuses on relatively large-scale issues but the same issues and others will be important at local levels. Obviously, this chapter cannot address local issues because they are unique to the communities addressed by particular textbook authors.

## Potential starting points for embedding ESD

MATHEMATICS	THEMATIC AREA	SAMPLE TOPICS
FUNCTIONS AND RELATIONS	Illness and health	Frequency and dissemination of diseases (comparing countries and/or historical development)
	Protection and use of natural resources and energy generation	Presentation of energy resources, generation and consumption of energy in the course of time, future prognoses
	Opportunities and risks of technological progress	Radioactive decay, for example, atomic power plants
	Global environmental changes	Climate data and climate change, for example, global warming
	Mobility, urban development and traffic	Development of street traffic, traffic fatalities and exhaust emissions in different countries and/or over the course of time
	Globalization of the economy and labour	Interest and repayment for private and public loans, developments at the stock exchanges
	Gemographic structures and developments	Population growth in different world regions
	Sustainable Development Goals	Developing indicators for specific SDGs, applying them over a time period, using them for prognoses
DATA AND STATISTICS	Food and agriculture	Household water demands in certain countries and worldwide
	Illness and health	Availability of physicians, midwives and medicine in industrialized and developing countries
	Water	Water scarcity, sources of consumption, availability of potable water in certain countries, regions or according to socio-economic status
	Education	Education and professions in industrialized and developing countries, child labour, status of universities
	Child labour	Distribution of child labour by region and products, comparative conditions and wages of child workers, profits of corporations using child labour
	Leisure time and globalization	Influence of holiday travel on environment and economy in the target countries
	Protection and use of natural resources and generation of energy	Generation and consumption of energy in the household (regionally, nationally, internationally) ----- The ecological footprint
	Globalization of economy and labour	Crises and upswings, data on public debts, per-capita debts, gross national products, labour markets, labour mobility
	Demographic structures and developments	Trends and consequences of demographics (national, cross-border, rural/urban)
	Poverty and social security	Financing of social systems such as pension schemes, unemployment insurance
GEOMETRY	Architecture	Symmetry and pattern in architecture (tiling, windows, etc), comparing across cultures
	Rights of people with special needs	Design of ramps for wheelchairs

Engaging with issues in the chart above or other issues would necessitate access to reliable data. Increasingly good data is becoming available publicly via the internet. At the same time, unreliable data is spread increasingly online so it is important for textbook authors to choose good data and to guide their textbook readers on how to identify and use reliable data on their own. Here is a list of some useful and reliable data sources:

- **The World DataBank**

<http://databank.worldbank.org/data/home.aspx>

This comprises an analysis and visualization tool, including time-series data on a variety of topics, particularly for all the SDG indicators. The time-series data is downloadable as xlsx or cvs files.

- **Global Peace Index**

[www.visionofhumanity.org](http://www.visionofhumanity.org)

The Institute for Economics and Peace provides statistics for measuring peace indicators and guidance on how to use such indicators.

- **Water Footprint Network**

<http://waterfootprint.org/en/resources/water-footprint-statistics>

The world's most comprehensive water footprint database ensures scientifically rigorous water footprint statistics are available for everyone to use. There are statistics on green, blue and grey water footprints of crops, derived crop products, biofuels and farm-animal products. All data is available at national and sub-national level.

- **Global Footprint Network**

[www.footprintnetwork.org/en/index.php/GFN/page/public\\_data\\_package](http://www.footprintnetwork.org/en/index.php/GFN/page/public_data_package)

A public data package is provided – free of charge for non-commercial purposes – to registered academics, educators (K-12 or primary school), non-governmental organizations with less than US\$1m in turnover and the media (print, web, broadcast).

- **International Data Base of the United States Census Bureau**

<https://www.census.gov/population/international/data/idb/informationGateway.php>

This offers a variety of demographic indicators for countries and areas of the world with populations of 5,000 or more. The database has given governments, academics, organizations and the public access to demographic data for more than 25 years.

- **FAOStat**

<http://faostat3.fao.org/home/E>

The Food and Agriculture Organization of the United Nations has a decentralized statistical system covering agriculture, forestry and fisheries, land and water resources, climate, environment, population, gender, nutrition, poverty, rural development, education and health plus many other areas.

- **World Resources Institute**

[www.wri.org/resources](http://www.wri.org/resources)

The institute produces maps, charts, data sets, infographics and other visual resources to help turn information into action. The products are based on the institute's data and research, which it tries to hold to traditional academic standards of excellence, including objectivity and rigor.

- **United Nations Population Fund**

[www.unfpa.org/world-population-dashboard](http://www.unfpa.org/world-population-dashboard)

The World Population Dashboard includes International Conference on Population and Development goals and demographic indicators for regions and countries.

- **Sustainable Development Knowledge Platform**

<https://sustainabledevelopment.un.org>

This platform focuses explicitly on SDGs.

When a textbook author has identified contexts that can be used to address SDGs, it will be necessary to cross-reference the developed mathematics with the curriculum to identify curriculum outcomes that are not included. For these, it will be necessary to work backwards and search for applications of the mathematics to identify other possible community and environmental contexts that could be addressed to develop the mathematical outcomes. Organizing a textbook to address the complete curriculum will require going both ways – from issues to curriculum and vice-versa.

*Increasingly good data is becoming available publicly via the internet. At the same time, unreliable data is spreading online. It is important for textbooks to use good data and to guide their readers on how to identify and use reliable data on their own*



## 3.5

## Helpful resources

Textbook authors can improve their engagement with issues by reading other publications that engage with community issues. We provide some examples in the last section of this chapter but more can be found in publications that describe teaching practices and publications that are designed as classroom resources. Many of the resources described below give great detail on the development of the community issue for mathematics classrooms. These examples may help textbook authors develop other contexts for school mathematics.

David Stocker's (2006) book *Maththatmatters: a Teacher Resource Linking Math and Social Justice* has many mathematically rich prompts that focus on critical social issues. The book is a collection of tasks that he has developed in his teaching practice at the middle-school level. There is also a second edition with all new tasks, *Maththatmatters 2* (Stocker, 2017). Other publications have fewer examples but greater discussion. Stocker's book does not have such discussion. Most of the resources exemplifying teaching for social justice feature work with middle- and high-school students but there are some examples from younger contexts. Beatriz D'Ambrosio and Celi Espasandin Lopes (2015) provide an example involving very young children.

As far as we know, the first comprehensive resource for mathematics education that critically engages with community issues is Marilyn Frankenstein's 1989 book *Relearning Mathematics: a Different Third R – Radical Maths*. Eric (Rico) Gutstein's more recent work follows the vein of Frankenstein's quite closely (especially his 2006 book *Reading and Writing the World with Mathematics*). He edited a book with Bob Peterson, *Rethinking Mathematics: Teaching Social Justice by the Numbers*, that features examples from different contributors (Gutstein and Peterson, 2005). In addition to doing scholarly research, Gutstein regularly teaches in a local high school (in Chicago) and presents at conferences examples from this teaching.

There are other collections of developed examples of mathematics teaching that engages social and environmental issues. A recent collection focuses on environmental issues but also includes social ones: *Teaching Secondary Mathematics as if the Planet Matters* (Coles, Barwell, Cotton, Winter and Brown, 2013). There are a few editions published by the National Council of Teachers of Mathematics that address gender issues (Secada 2001), cultural issues (Secada, 2000) and issues relating to indigenous peoples (Secada, Hankes and Fast, 2002). A more scholarly collection edited by Brian Greer, Swapna Mukhopadhyay, Arthur Powell and Sharon Nelson-Barber (2009) positions engagement with social issues as cultural responsiveness.

More examples with discussion can be found interspersed in journal articles and conference proceedings. The examples referred to in this chapter are in English because it is the language of this guidebook and most scholarship is published in English. However, there is significant work in other languages. For example, this guidebook is largely inspired by work carried out in Germany, notably a mathematics chapter by Antonius Warmeling in *Curriculum Framework: Education for Sustainable Development* (2006).

Other resources focus more generally on the ideas relating to social justice in mathematics education, rather than providing examples of how to do it. Some chapters in the Greer, Mukhopadhyay, Powell and Nelson-Barber book listed above also fit this description. Ubiratan D'Ambrosio was one of the first mathematics educators to reflect deeply on how mathematics relates to social justice and to write about cultural diversity in mathematics. He has published mostly in Portuguese but has also engaged with English speakers. The chapter entitled 'Cultural framing of mathematics teaching and learning' (D'Ambrosio, 1994) is one of his earlier reflections and a later chapter, 'A nonkilling mathematics?' (D'Ambrosio, 2011), draws on his years of work. It is possible to watch D'Ambrosio speak about his work on the Mathematics Education and Society website, which also features talks recorded in 2015 by Bob Peterson, Munir Fasheh and Anita Rampal in which they discuss ethical mathematical teaching (<http://mescommunity.info>).

These resources focus attention on the kinds of problems that are used to engage mathematics students and prompt reflection on how these problems relate to equity concerns. There is also a large body of research on the nature of interaction in mathematics classrooms. This underscores the value of students interacting with each other and the importance of their engagement in open-ended problems. These forms of communication help students develop as engaged citizens, as noted above. Some of the research shows that this kind of interaction in mathematics classrooms develops improved performance on procedural mathematical outcomes and some of the research focuses on the way this interaction supports equity. A book chapter by David Wagner (2011) explains why these are related to each other, and the work of Jo Boaler is best known for showing that these two outcomes correlate. Her article entitled 'How a detracked mathematics approach promoted respect, responsibility and high achievement' (Boaler, 2006) provides a good introduction to her work and her website has more resources ([www.youcubed.org](http://www.youcubed.org)). (See also sections 3.2 and 4.3 of the Introductory chapter for elaboration on teaching and learning methods that support ESD.)

## 3.6

## Guidelines for embedding ESD in mathematics textbooks

In summary, it is important for mathematics textbooks to show examples of how mathematics can be used to support SDGs, including disaster risk reduction. In addition to examples that help students to visualize injustice and unsustainable practices, examples of disasters – when people’s best efforts go horribly wrong – help students to plan ways to address these challenges. It is also important to write the materials in a way that expects and instructs the students to interact with each other to solve complex problems. This teaches them to listen to other people, develop respect for other’s viewpoints and to make mathematical choices that most responsibly address the complex problems our communities face.

We outline below 15 guidelines for creating mathematics curriculum resources that support ESD. These are developed more fully in the examples in the next five sections of this chapter. In fact, this list of 15 guidelines comes from our work on developing those examples. Our approach to developing the guidelines is an example of the intimate relationship between abstractions, such as the guidelines below, and considerations in particular situations, as described in the development of the examples in the next five sections. Mathematics teaching and curriculum resources should maintain close connections between the abstractions and particular examples in a similar way.

The last five sections of this chapter provide examples that might be used in mathematics classroom resource materials. Each example includes a discussion of the issues facing authors wanting to embed sustainability, peace and global citizenship into their materials, and offers guidance on how to handle those issues.

*We outline 15 guidelines for creating mathematics curriculum resources that support ESD*

### ● Real contexts

Use real mathematical contexts (as opposed to imaginary contexts or abstractions) to support the message that mathematics is a useful tool for addressing human physical needs in sustainable ways (especially related to SDGs 6–9 and 11–15). (See *considerations for curriculum authors 1A, 2C, 3C.*)

(See *considerations for curriculum authors 5B and ESD competency in the Introductory chapter – reflecting on values.*)

### ● Access to data

Cite sources for data used in curriculum resources and point to other possible sources for further investigation. When students access publicly available data, they develop the skills and confidence for doing this when they face sustainability challenges outside school. (See *considerations for curriculum authors 1B.*)

### ● Current issues

Acknowledge that any real context may soon feel out of date or may not be particularly relevant to certain students. Textbooks may position real contexts as examples of people addressing their current and local issues. This can inspire students to consider how mathematics may be a useful tool for sustainable development in their own contexts. (See *considerations for curriculum authors 3E, 5A.*)

### ● Human activity

Draw attention to people using mathematics to address social issues with sustainable development sensibilities. Attention to such human agency can appear in exercises, investigations, worked examples or asides. Be sure to identify people from diverse demographic groups (especially marginalized ones) so students can visualize themselves using mathematics powerfully (SDG 4). (See *considerations for curriculum authors 1E, 2C, 2E, 3A, 4C.*)

### ● Complexity

Do not oversimplify contexts. Such oversimplification may suggest that the mathematical abstractions are more important than the contexts they were invented to address, or that mathematics cannot handle real complexity. As noted above, there are limitations to how mathematics can be used in a real context but it is important for textbooks to pursue the complexity as appropriate. (See *considerations for curriculum authors 2F, 4A and ESD competency in the Introductory chapter – dealing with systems.*)

### ● Foregrounding context

Foreground the context of mathematical work. Textbooks may be organized around contexts or around mathematical concepts or processes. Foregrounding contexts draws attention to socio-cultural concerns and allows connections to develop between different areas of mathematics. (See *considerations for curriculum authors 2A.*)

### ● Values

Acknowledge the values behind choices for examples and contexts. Any choice of context suggests that the topic is an important one for students. There are politics involved in making such a choice because other issues may be more important to the students.

### ● Interdisciplinarity

Consider connections to other school subjects. Any mathematical lesson that uses a context relating

to peace or sustainable development is ripe for cross-curricular discussion. (See *considerations for curriculum authors 1F, 2F*.)

### ● Sensitivity to marginalization

Balance the experience of students with potential learning gains by minimizing potential embarrassment of marginalized students. Directly addressing an equality issue (gender, ethnic, etc) is necessary but may draw attention to disparities and stereotypes among students. (See *considerations for curriculum authors 1F, 2D and ESD competency in the Introductory chapter – thinking and acting inclusively*.)

### ● Opening dialogue

Avoid thinking that your publication needs to maintain a singular focus on SDGs. Any connection to an SDG could go further but it is acceptable and even good to leave space for teachers and students to advance the conversation. Related to this, even a few explicit connections to sustainable development may prompt teachers and students to consider connections in mathematical ideas that the textbook does not connect to SDGs. (See *considerations for curriculum authors 3B, 4B, 5C and ESD competency in the Introductory chapter – participating and collaborating*.)

### ● Collaboration

Encourage and initiate group work by writing questions and instructions that ask for it. This enables students to hear each other's ideas and thus develop their sensitivity to the value of other voices (related to SDGs 5, 10, 16). (See *considerations for curriculum authors 1C and ESD competency in the Introductory chapter – participating and collaborating*.)

### ● Access

Minimize the cost of curriculum resources (this is an issue for publishers more than it is for authors). The cost of a textbook affects its accessibility, which is a social justice concern (SDG 4). For a textbook to be accessible, it also needs to use language that is comfortable for the student and contexts that are familiar. These elements are more the responsibility of authors than publishers. (See *considerations for curriculum authors 2B, 3E, 3F*.)

### ● Using technology

Consider the technology available to the students who will be using the textbook and capitalize on it as a source for information. In addition to using computers to access information online, smartphones can be used creatively to collect and map data in a community. Today's smartphones can be equipped with useful features such as GPS capability, seismometers and apps that analyze sound. For an example of smartphone use, please see

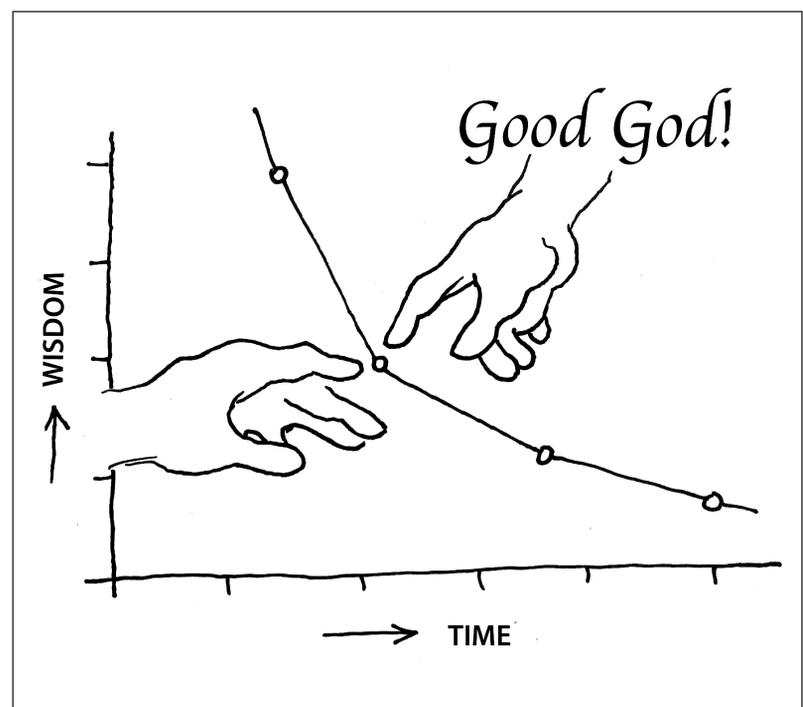
the work of Laurie Rubel (for example, Rubel, Hall-Wieckert and Lim, 2016).

### ● Courage

Address politically sensitive issues boldly but consider the risks students and teachers may face when exploring them. Sensitive issues are the most important ones and should not be avoided, but it is wise to leave judgments to the students and teachers based on their mathematical investigation and knowledge of the relevant contexts. Avoiding politically sensitive issues suggests they are not as important as others. (See *considerations for curriculum authors 5D*.)

### ● Trust

Allow the teachers who work with the textbook to exercise their professionalism and guide students through the challenging conversations that will arise with real community and environmental issues as the contexts of their mathematics. It may be that teachers are unable to do as much preparation as one would like but the profession can only grow in capability when teachers are entrusted with their role. It is unwise to try to micromanage the teacher through the textbook. On the other hand, teacher guides that accompany textbooks are an appropriate space in which to advise teachers on handling ESD effectively. Students must be conscientious and compassionate in their work when dealing with complex issues and textbook authors need to trust them to do this. Without such trust, students will not develop the required skills and experience to be active citizens and stewards of the community and environment.



## 4.0

## Examples of embedding ESD in mathematics text

## 4.1

### EXAMPLE 1

#### Measurement and comparison

People develop standards to measure things important to them. These standards enable comparisons to be made with better precision. As with any measurements, it is worth discussing what is measured and what is not. The text below is an example of an investigation that explores a recently developed measurement unit, the body mass index (BMI), which represents the ratio between a person's mass (in kilograms) and the square of the person's height (in metres). This example is designed with Grade 8 children in mind (approximately 13 years old) but could be immediately applicable to a range of ages depending on curricular expectations in different jurisdictions. The context draws on statistics drawn from reputable and accessible data sources.

Example 1 involves comparisons between countries, which can connect to the experiences of many students. It connects BMI with SDGs 1 and 2 'no poverty' and 'zero hunger'.

#### CONSIDERATIONS FOR TEXTBOOK AUTHORS

**1A** Mathematical education resources may use imaginary or real contexts. With imaginary contexts, it is possible to devise a situation that helps focus on particular mathematical skills. However, contrived situations like this do not reflect the real, more messy numbers that people experience outside school. Using real data sends the message that mathematics is relevant to the lives of students and others. It also supports students' attachment to the mathematics because they work with information that directly connects with their experiences.

**Guideline – real contexts**

**1B** The textbook may provide all the data necessary for students to complete the task or some of it. Either way, it is important to cite sources for real data used in the textbook and other possible sources for further investigation. Citing the sources makes it clear to students that the data is real and sends the message that mathematics is applicable to real situations and inspires confidence in students' ability to use their mathematics with real data. In this example, some useful data is given in the task but some of the questions direct students to look at further data. Even though data sources change over time, it is good for students to access publicly available data so they develop the skills and confidence for using them.

**Guideline – access to data**

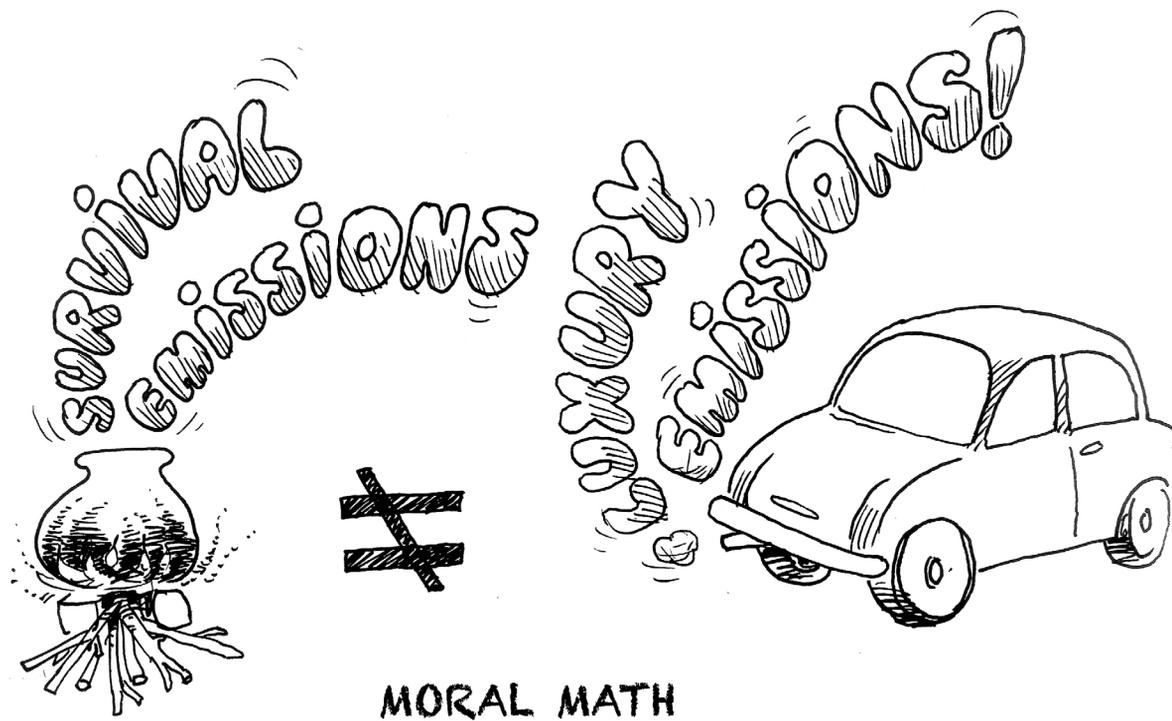
**1C** A textbook can ask explicitly for group or individual work. Example 1 is designed for group work. Collaboration is an important part of educating for peace and especially for global citizenship. Collaboration is also important for developing sustainability because it enables the inclusion of multiple perspectives. In groups, students hear each other's ideas and are motivated to explain

their thinking. Justifying mathematical thinking is an important part of citizenship because it is part of responsible public discourse and it underpins challenges to traditional or current practices. Although this example is designed for group work, it does not explicitly say it requires groups. Group work can be implied with requests for explanation (for example, 'tell each other') but it could be suggested more strongly (for example, 'decide as a group' or 'prepare a presentation for your class'). When students are developing presentations on real societal issues, it can be very productive for them to present to relevant community organizations. However, it is relatively challenging to specify such audiences in a textbook because the author cannot predict what audiences would be available to students to address in different contexts. When students present to people outside their classroom, they tend to do better work – with clearer communication and more care put into ensuring they understand the situation.

**Guideline – collaboration**

**1D** Real contexts that have meaning for students are likely to cause embarrassment for some of them. Overweight students in the class may be embarrassed by this example. Other contexts may draw attention to certain students' wealth, poverty, parental education levels, minority ethnic identities, and the list goes on. Contexts that address community issues may connect students to particular industries (perhaps through a parent's occupation) or to particular environmental concerns. However, if mathematics education resources do not use real contexts that matter to students, their mathematics will not seem meaningful. To reduce the possibility of shame, this example does not ask students to measure themselves to calculate their own BMIs,

*Justifying mathematical thinking is an important element of citizenship because it is part of responsible public discourse and underpins challenges to traditional or current practices*



## MORAL MATH

although it would be conceptually helpful for them to do this. Textbook writers need to carefully balance the experience of students with potential gains, including mathematical gains and improved understanding of an issue. It is necessary to consider the possible discomforts students may face when doing a task, and to think creatively about how this discomfort could be reduced.

**Guideline – sensitivity to marginalization**

**1E** Word problems in mathematics education texts, whether they are parts of exercises, investigations or examples, often provide examples of people doing mathematics to address social issues and/or expose social inequalities. A text may draw attention to this. In this way, the example overleaf might have accompanying commentary that points out the mathematics in the source material: ‘People sometimes invent units to measure something important to them. This makes it possible to include the idea in conversations that matter to them. The BMI is an example of this.’ Or ‘Bar charts and line graphs are often used by decision-makers to understand trends and make predictions. This graph helps us understand the significance of malnutrition in our world.’ It is not necessary to have such commentary on every mathematical task because students can generalize. They see how people are using mathematics in the context here and they also pay attention to people’s mathematical choices in other contexts.

**Guideline – human activity**

**1F** Contexts for ESD are normally complex and interdisciplinary. To build students’ understanding of the mathematics, it is helpful to ask questions that may not seem immediately relevant to the mathematics. It is necessary to understand the context to understand the way the mathematics works in the context. In the example overleaf, there are questions such as ‘Research how the word “undernourished” is defined. Why do you think it is defined like that?’ or ‘What

are some reasons for these changes in BMI?’ In fact, definitions of undernourishment will often rely on some measurement (and thus mathematics). Also, when considering growth and trends in graphs, it is necessary to think about the reasons for the trends.

**Guideline – interdisciplinarity**

The first set of opening questions requires students to understand the mathematical communication in the excerpt from the Worldwatch Institute and to communicate that information in another way. The questions ask for possible reasons, which would direct students to think about the social context in connection to the mathematics. The questions also ask for a procedural application of the BMI, which is another level of understanding (sometimes called ‘instrumental understanding’ as opposed to ‘relational understanding’). The first set of continuing questions also demands some procedural work and some that connects the mathematics to the social context.

The second set of opening questions and connecting questions focus on interpreting the graph, which requires previously learned graph skills. This is supplemented by explicit connection to SDGs and draws attention to the strong connection between definitions of categories and the social contexts the categories are supposed to address. One of the connecting questions engages students in modelling when they are asked to develop a reasoned argument for a projection of the data into the future. They will have to think about context in relation to mathematics as they consider the possibility of eradicating malnourishment – for example, is the trend linear or does it show exponential decline?

The connecting questions bring the two contexts together. Students are invited to consider the kinds of statements they would want to make about poverty/wealth and health, and to use their mathematical and communication skills to achieve their purposes.

*Contexts for ESD are normally complex and interdisciplinary. To build students’ understanding of the mathematics, it is helpful to ask questions that may not seem immediately relevant to the mathematics*



## Too much or too little?

### The number of overweight people is on the rise

The number of overweight adults worldwide jumped from 1.454 billion people in 2002 to 1.934 billion in 2010, an increase of 25 per cent. Some 23 per cent of individuals aged 15 or older were overweight in 2002, while in 2010 the figure rose to 38 per cent – even though the number of adults increased by only 11 per cent during these eight years. Much of this change occurred in the industrial world. Economic, cultural and possibly genetic factors all played a part. But in every country where people have become heavier, the result has been the same: an increase in preventable medical problems.

The term 'overweight' is used here for people with a body mass index (BMI) of 25 or greater. BMI is a measure relating a person's height to weight. (A person with a BMI of 30 or above is usually labelled 'obese' but here the term 'overweight' covers overweight and obese populations combined.)

The data considers people aged 15 and older in 177 nations (an area that accounts for the vast majority of the world's population).

(Source: <http://vitalsigns.worldwatch.org/vs-trend/levels-overweight-rise>, Worldwatch Institute Washington, 14 June 2011.)

### Opening questions

- What is the Worldwatch Institute saying to us? Describe it in your own words.
- Explain its conclusions using the data.
- What are some reasons for these changes in BMI?
- Investigate the calculation of BMI for a human who is overweight or even obese.
- What does this quote ‘even though the number of adults increased by only 11 per cent during these eight years’ mean?

### Continuing questions

- What was the number of all people in the researched nations and age group?
- What do you suppose are the differences in developing or industrial countries? Is there a difference between women and men?  
(Data can be found at <http://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics>.)

### Halve the proportion of undernourished people (1990–2015) – Target 1c of the Millennium Development Goals

Current estimates suggest that about 795 million people are undernourished globally. This means that nearly one in nine individuals does not have enough to eat. The vast majority of them (780 million people) live in the developing regions. However, projections indicate a drop of almost half in the proportion of undernourished people in the developing regions, from 23.3 per cent in 1990–1992 to 12.9 per cent in 2014–2016.

(Source: *The Millennium Development Goals Report 2015*.)

### Opening questions

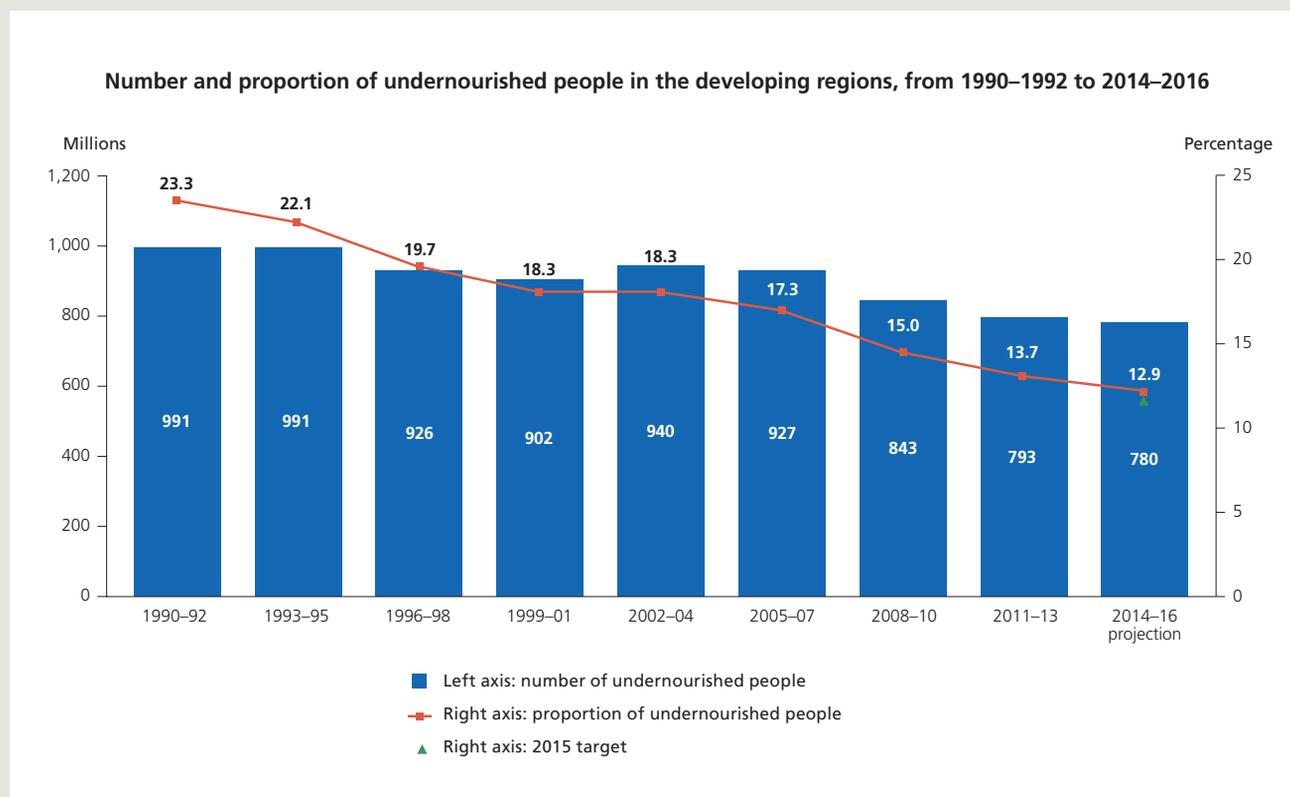
- Tell each other what you see in the graph.
- Research how the word ‘undernourished’ is defined – why do you think it is defined that way?
- Which UN sustainable development goals are being addressed?
- How many people lived in the world between 2014 and 2016? How many were there between 1990 and 1992?

### Continuing questions

- Which is more important, the proportion of undernourished people or the actual number of undernourished people? Develop an argument for each answer.
- Can you create a reasonable projection? Based on this graph, what do you expect to happen in the years up to 2030?

### Connecting questions

- Compare the number of undernourished and overweight people, for example, in 2010.
- In the industrial countries, we may find the term ‘underweight’. Research different definitions of ‘underweight’ and ‘undernourished’ (one definition of underweight is a BMI < 18.5).
- Design a presentation that addresses the issues of BMI and malnourishment. Use examples of people with the same height and different weights to illustrate the categories of overweight, underweight, etc. (or use examples of people with the same weight and different heights).



Source: [www.un.org/millenniumgoals/2015\\_MDG\\_Report/pdf/MDG%202015%20rev%20\(July%201\).pdf](http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf), p. 20

## 4.2

## EXAMPLE 2

### Shape and space

*Math-Magic – Book 4* is published by India's National Council of Educational Research and Training (NCERT, 2007). The 170-page book covers the range of outcomes required for nine-year-olds in India and is distributed at the cost of 30 rupees (less than 0.5 euros) per book. It is organized around contexts rather than mathematical concepts. For example, the first context features a story about brickwork. The chapter covers 12 pages and is used to engage students in counting large numbers, symmetry, perspective drawing, design of arches and triangles using rectangular bricks, estimation, measurement and multiplication. (For a more detailed description of the book and the others in its series, see Anita Rampal's plenary address from the Mathematics Education and Society conference in 2015. Both the paper and her talk relating to the paper are available on the conference website: <http://mescommunity.info>.)

In Example 2, we will use the same context for a possible textbook page that develops concepts relating to tiling and tessellations. The opening paragraph (in italics) is copied from the *Math-Magic* textbook and the photo represents some tiling similar to that done by the Jagriti School masons. The example connects with United Nations SDGs 9 and 10 (innovation and reduced inequalities). The story may help reduce inequalities because it highlights the capability of people who are often marginalized, positioning them as innovators who build structures for their communities.

#### CONSIDERATIONS FOR TEXTBOOK AUTHORS

**2A** Mathematics textbooks may be organized around contexts or around mathematical concepts or processes. An advantage of organizing around contexts is that more details about the context can be developed (which is good for understanding socio-cultural situations) and more mathematical connections may be developed. For example, symmetry is connected to measurement, estimation is connected to shape and multiplication, and estimation is involved in all aspects of mathematics. These connections are important for developing systems thinking. A concern may be that teachers may need higher mathematical competence to support students' mathematical skill development when the resource seems to foreground context. However, teachers' mathematical competence will increase as they engage students in such rich contexts, just as the children's competence will grow. The alternative is to use simplified and narrow concepts, which would limit the development of both teachers and students.

**Guideline – foregrounding context**

**2B** The cost of a textbook affects accessibility, which is a social justice concern.

**Guideline – access**

The first chapter of this book features beautiful architectural photos of a 300-year-old tomb in an Indian region where Muslim people are marginalized and their technical skills are not typically recognized. The text celebrates the skill of the tomb's Muslim architects and also that of contemporary Muslim masons, who have created beautiful tiling for the Jagriti School in Murshidabad. The text does this subtly – it does not explicitly draw attention to the way this story provides a counter-example to the region's dominant narratives – for example, it does not say: 'See how skilled and creative Muslim people can be.'

**2C** The selection of story contexts for mathematical problems allows us to portray majority or minority cultures as heroic (exercising skill and agency) or passive. These selections subtly influence students' views about people from these demographic groups and provide an opportunity to counter dominant narratives. However, students may see such choices as ridiculous if the stories are fictional or if the text overstates the skills. True stories are preferred, especially if they are well documented. As noted in consideration 1a, real data and real stories enable students to envisage themselves using mathematics in their experiences.

**Guideline – real contexts, human activity**

**2D** As identified in consideration 1D, it is important to think about how the selection of contexts and protagonists will affect students from different demographics in the classroom. In this case, one might wonder how a Muslim student or the child of a brick worker would feel. Example 2 is written to celebrate human design so it is hard to imagine how someone might feel slighted by it.

**Guideline – sensitivity to marginalization**

**2E** It is always important to think about where the text directs students' attention. As noted in consideration 1E, an author may choose to identify mathematical processes explicitly or not. In this case, the people in the story become excited by the ingenuity of others, which is a way of identifying human mathematical action. Task 7 in Example 2 explicitly requests students to think about people working with geometry.

**Guideline – human activity**

**2F** It is important to think about how mathematical tasks move between particular contexts and the

*Mathematics textbooks may be organized around contexts or around mathematical concepts or processes. An advantage of organizing around contexts is that more details about the context can be developed (which is good for understanding socio-cultural situations) and more mathematical connections may be developed*

## EXAMPLE 2

## Beauty and efficiency

*This is the true story of Jagriti School in Murshidabad (West Bengal). When its building was being made, there was a plan to make brick patterns on the floor and walls. Jamaal, Kaalu and Piyaar were the masons for the brickwork. They wanted to get new ideas for the school building. So they took their other friends to see the old tomb of Murshid Kuli Khan. The masons came back excited. Jamaal said: 'Ah! In those days they had made so many interesting brick patterns. We had forgotten these! Let us make some nice designs on the floor of this school.' Each mason made a different brick pattern.*

1. Draw some other designs you could make with rectangular bricks like these on the right.
2. What other shape for a brick could be used to cover a floor?
3. Measure the angles of your shapes that could cover a floor.
4. Find the sum of the angles that meet at one point in your brick patterns.

For thousands of years, people have used bricks to build structures and to tile floors. In both cases it is important to cover a space with no gaps. Architects also want to make their work beautiful. Different cultures often have unique design preferences. Muslim architecture is known for its complex tiling. The tiling in this photo is basic and very practical.

In mathematics, the word 'tiling' is used to talk about the study of shapes that can be placed alongside each other to fill space completely without leaving gaps. The sum of the angles at any intersection of shapes must be  $360^\circ$ , which is a full rotation.

5. Use your knowledge of angles to decide whether it is possible to tile:
  - a) a square
  - b) a regular pentagon
  - c) a regular hexagon
  - d) any triangle

6. Design the tiles for a floor in a room you like. Think about the angles at the intersections of the tiles. Think about colour. Write a paragraph to describe the angles in your design and the ideas you tried to convey in your art.
7. Extension: make a list of places where you have seen rectangles. Which of these are natural and which are human made? Why do you think people are so interested in rectangles?



Source: [www.flickr.com/photos/mattimattila/7013371275](https://www.flickr.com/photos/mattimattila/7013371275)

abstract. Example 2 moves back and forth between the particular and the general. This is a way of ensuring students think of their abstractions and generalizations in terms of how they are used in particular contexts. This both develops skill with generalization and, hopefully, avoids the dangers of abstraction because the abstractions are connected to contexts consistently.

Guideline – **complexity, interdisciplinarity**

The tasks in Example 2 invite students to design shapes that they like aesthetically and/or fit their practical needs. This is connected to the technical skills of measuring angles and the abstract idea that the angles meeting at a point of tiling must have a sum of  $360^\circ$ . This general principle is applied to various known shapes and to the particular shapes the students choose in their designs.

4.3

**EXAMPLE 3****Algebra**

The following example is written to demonstrate ESD in the algebra curriculum.

**CONSIDERATIONS FOR TEXTBOOK AUTHORS**

**3A** The grammar of curriculum materials is significant. This chapter is written in a traditional way, with no mention of the authors. This matches the voice of the other chapters. However, the next paragraph immediately below uses a different voice in which the authors refer to themselves, using first-person pronouns (I, my, me, we, our, us). An 'I' or 'we' voice reminds readers that the authors have a perspective and that other perspectives are possible. These first-person voices also help the reader to understand the connection between decisions and goals; it allows the reader to see how the author(s) sympathize or empathize with their experiences. There are some mathematics textbooks that include first-person texts (for example, Small et al, 2007) but they are rare. An interest in sustainable development and peace would be well served by text that identifies the author's perspective. It underscores the significance of participation and responsibility, which are universal principles for sustainable development.

**Guideline – human activity**

In this chapter, we wanted to include an example that develops an important mathematical concept that is relatively difficult to connect to sustainable development or peace. We knew from our own writing experiences that certain mathematical topics lend themselves better than others to any considerations for embedding values, pedagogical approaches or general structures. Algebra is relatively difficult to connect to peace and sustainable development because it is, by nature, a step into abstraction. In other words, algebra is one of the most important tools for operating independent of context (the opposite of honouring local knowledge, the opposite of participation – both of which are universal principles for sustainable development). As we outlined at the beginning of the chapter, there is danger in abstraction but there is also value in it. An important movement in mathematics education is the Algebra Project, developed by Bob Moses to redress inequities in access to high-level mathematics in the USA. In this context, 'Algebra' is the name of a high-school course that includes algebra and other topics. The Algebra Project promotes good pedagogy in algebra and the other topics. The name 'Algebra Project' refers to the course more than to algebra. The course enables access to higher education, so it is important to ensure access to the course and success for marginalized demographics.

Example 3 was the hardest to write for another reason, too. It is an example of exposition, where the

other examples are of student tasks (which can be used as examples, exercises or investigations).

**3B** Most mathematics textbook materials include some exposition. Word problems and investigations (when used as examples or in exercises) lend themselves more easily to embedding sustainable development because they invite response from students. Exposition tells students things and typically presents one point of view. In this way, it goes against the ESD competency 'participating and collaborating'. Nevertheless, some information is necessary to invite participation. To illustrate, Examples 1 and 2 above both provide some information before inviting students to do things.

**Guideline – opening dialogue**

Example 3 is designed to introduce the concept of a variable to students at Grade 5 or 6. The example develops the idea of a variable and uses a context of inequitable access to water, which relates to SDG 6 (clean water and sanitation). The context is not particularly significant to the mathematics for most of the exposition, but this changes with the closing questions that compare two situations. When students are asked to use their new mathematical notation to describe the situation they would promote, they have to connect the mathematics to their ideas about equity. The people in this imaginary context do not use the variable or algebra to address the inequity. However, this example text invites students to use algebra to describe and represent the inequity and guides them in how best to do it.

**3C** Any mathematical lesson that uses a context relating to peace or sustainable development is ripe for cross-curricular discussion. Example 3's text could also be used as a prompt for social studies outcomes. Authors of mathematics textbooks would benefit from browsing through the United Nations' SDGs and considering how these goals relate to the experiences of the students who are likely to be using the textbook. Example 3 uses a fictional context unlike the first two examples in this chapter (see consideration 1A).

**Guideline – real contexts**

**3D** As was the case in Example 1 (see consideration 1D), this example has the potential to embarrass students. Children with poor access to water might be embarrassed by their families' poverty and others with good access might be embarrassed by their relative privilege. The text in this example does not

*Any mathematical lesson that uses a context relating to peace or sustainable development is ripe for cross-curricular discussion*

## EXAMPLE 3

## Showing a relationship



Source: <https://commons.wikimedia.org/w/index.php?curid=19202480>

Look at the container (ghada) pictured left. In the winter months, Kumar fills one of these containers with water once a day from the lone tap in the compound that supplies municipal water to 20 other families too. Sometimes Kumar manages to fill the ghada fully

and sometimes he only manages to fill half the ghada before the tap runs dry.

Kumar's family of four has only the water he manages to bring in the ghada for drinking and cooking for the whole day. At Aruna's home, in an expensive, middle-income-group colony nearby, water is always available. Aruna's family uses ten times the amount of water per day that Kumar's family uses for cooking and drinking.

- If Kumar's family uses 1 litre a day, Aruna's family consumes  $10 \times 1$  litres that day.
- If Kumar's family uses 2 litres a day, Aruna's family consumes  $10 \times 2$  litres that day.
- If Kumar's family uses 7 litres a day, Aruna's family consumes  $10 \times 7$  litres that day, and so on.
- Do you see a pattern?
- How would you write that down?

The relationship between the two amounts can be written this way:

The amount Aruna's family uses in a day	= 10 x	The amount Kumar's family uses in that day
---	--------	--

If you are going to write or talk about this relationship often, it would be good if there were a shorter way of representing this pattern rather than writing out the equation every time. We can represent the amount of water Aruna's family uses in a day by the letter  $a$ , and the amount used by Kumar's family in that day by the letter  $k$ . Aruna's family uses  $a$  litres daily and Kumar's family uses  $k$  litres daily.

- Then the relationship could be written like this:  
 $a = 10k$

- So, if  $k = 5$ , then  $a = 10 \times 5 = 50$

- If  $k = 3.5$ , then  $a = 10 \times 3.5 = 35$

Here  $k$  represents an unknown amount. In fact, did you notice what happens to the value of  $a$  as the value of  $k$  varies? It keeps varying (changing). Again, if the value of  $k$  changes, what happens to the value of  $a$ ? Both these values change in a way that keeps the relationship between  $a$  and  $k$  the same. Since the values of  $a$  and  $k$  change, both  $a$  and  $k$  are called variables, that is, their values vary.

Now, if you look at the relationship  $a = 10k$ , you will see Kumar's family only has one tenth of the water Aruna's family uses per day:

$$k = a \div 10 \text{ or } k = a/10$$

After a few months, summer has come and Aruna's family starts using more water, while Kumar's family gets even less than before. In fact, Aruna's family starts using 25 times the amount Kumar's family manages to get per day.

- How would you show this relationship using variables?
- Do you think it is right for some families to get very little water and for others to get lots and lots of water? Discuss this with your friends.
- What pattern of water distribution would you want in your locality? Write the pattern using variables.

judge; it does not criticize wealth or poverty. It is appropriate to leave such judgment and discussion in the hands of a teacher in discussion with students.

**Guideline – sensitivity to marginalization**

**3E** Accessibility of materials is important, as identified in consideration 2B, but it means more than the cost of textbooks. Accessibility also refers to the potential for readers to understand the contexts. When choosing contexts for mathematics textbooks, it is important to use situations that students will understand and social tensions that relate to their concerns. Of course, this is a challenge when the text is developed to be used widely. Example 3 is written to be accessible to children in India.

**Guideline – accessibility, current issues**

**3F** A further meaning of accessibility is the language of the text. All our examples are in English, which is not the first language of many people learning mathematics. It is important to provide materials that students can read, which means using languages they know fluently, and also using vocabulary and sentence structure that is within their comfort zone. Example 3 is written more conversationally than many typical mathematics expositions.

**Guideline – accessibility**

In this example, students are introduced to the central idea of algebra, which is, by nature, a step into the abstract. In the tasks at the end, it connects questions relating to equity with algebraic representation. Thus students will have to be able to use algebraic notation properly and they are led to think about it in terms of a social situation, motivated by equity concerns.

## 4.4

## EXAMPLE 4

### Modelling and prediction

The other four examples in this chapter focus on equity concerns. Example 4 features the human response to the environment, specifically to SDGs 13 (climate action) and 15 (life on land). The example is drawn from work on typhoon data carried out as part of the lesson study tradition. It was presented at the APEC-Khon Kaen International Symposium in Thailand in 2013 under the title ‘Innovation of mathematics education through lesson study challenges to emergency preparedness for mathematics.’ This annual conference, sponsored by APEC (Asia Pacific Economic Cooperation), is an example of the increasing global responsiveness to the UN SDGs. See the conference websites ([www.criced.tsukuba.ac.jp/math/apec/apec2013](http://www.criced.tsukuba.ac.jp/math/apec/apec2013) and [www.crme.kku.ac.th/apec-thai2013.html](http://www.crme.kku.ac.th/apec-thai2013.html)) for more examples of lessons addressing typhoons and other emergency preparedness situations. The mathematics of Example 4 is developed further by Nobuaki Kawasaki and Masami Isoda in an e-textbook (available at [www.crme.kku.ac.th/apec-thai2013.html](http://www.crme.kku.ac.th/apec-thai2013.html) by following the link ‘Expectation of some natural laws by using mathematics – analysis of typhoon’s data’). The e-textbook used data distributed by the Japan Meteorological Agency ([www.data.jma.go.jp/obd/stats/etrn/index.php](http://www.data.jma.go.jp/obd/stats/etrn/index.php)).

*The way text positions students has strong implications for how they think of themselves in relation to mathematics and also in relation to human challenges. It is best to use contexts that have the student acting in the role of someone taking leadership for positive action*

#### CONSIDERATIONS FOR TEXTBOOK AUTHORS

**4A** The context of the schooling is a significant factor in the construction of texts that will speak to those traditions. This example follows a Japanese tradition of inquiry whereby students dwell on a single, complex problem. Guided by their teacher, the students connect their experiences to the problem and suggest a variety of ways to think about the posed questions over one or more class periods. Thus, the text in Example 4 may not work well in a context where students and teachers are not yet accustomed to this kind of deep inquiry. However, it is the kind of inquiry that addresses ESD well so it is worth considering how a textbook can contribute to developing this kind of approach.

**Guideline – complexity**

This example uses weather data to engage students in the mathematical process of prediction. It is designed for Grade 10 students. The text guides students through the kind of processes used by meteorologists, engineers and planners, who make decisions based on weather and climate patterns. This text addresses sphere geometry and boxplots. It also positions mathematics as a useful tool for meeting human needs in the face of disasters.

**4B** In any context, there is potential for deeper connections to sustainable development goals. In this example, the text refers explicitly to life on land but it naturally connects to a deeper question about causes. In this case, climate change is a factor. Similarly, for other mathematical contexts,

teachers may engage students in dialogue about the causes of the situation in the context. Those deeper conversations may explore more SDGs and may also (or otherwise) explore further mathematics. The text need not guide the teacher do to this but it is a possibility. Authors need to consider how deep they want to take students in their questions.

**Guideline – opening dialogue**

**4C** The way the text positions students has strong implications for how they think of themselves in relation to mathematics and also in relation to human challenges. It is best to use contexts that have the student acting in the role of someone taking leadership for positive action. In Example 4, the task positions the student as an expert analyst (not necessarily a potential victim of the typhoon) who is advising others what to do in the face of imminent danger. The students are positioned as an expert with their mathematics and as an ally to people who are suffering or potentially suffering.

**Guideline – human activity**

#### Other considerations for textbook authors

As identified in consideration 1A, this example uses real data and thus sends the message that students can use their mathematics to address their concerns. As identified in consideration 1B, this example cites its sources to underscore the reality of the data and to develop students’ ability to find data relevant to their lives. Example 4 explicitly identifies mathematics as a human endeavour, unlike the other examples in this chapter (see consideration 1E), and it also positions the student as a user of mathematics in human concerns. There are no actors except the student, so no majority or minority actors in the narrative (see consideration 2C). This task has strong potential for cross-curricular discussion (see consideration 3C) because it connects well to science and geography.

**Guideline – real contexts, access to data, human activity**



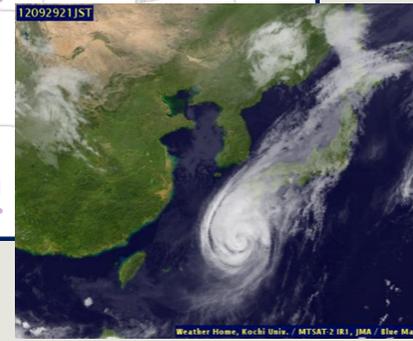
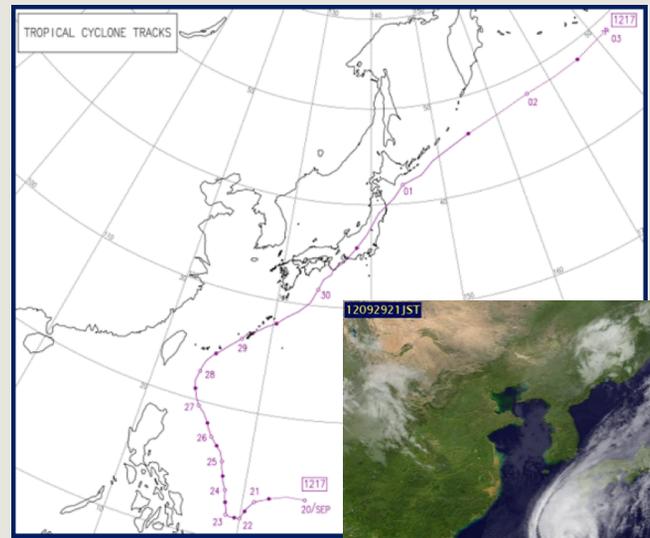
“...you need not be 100% accurate”

**EXAMPLE 4**

# How can we prepare for a typhoon?

These images come from a recent typhoon in East Asia. On the map, the points and numbers indicate the centre of the typhoon on each day as it progresses.

1. Where does the speed of the typhoon increase? How would you explain this? (Consider modelling the motion by estimating the angles from the centre of the earth on the map for each day. You can use the lines of latitude and longitude for your estimates.)
2. Imagine how much water will be dropped by this typhoon. Explain how you came to your conclusion. (Consider the size of the cloud of the typhoon. What is its area? What assumptions are you making about the amount of water in the cloud?)



Mathematics is a necessary tool for predicting future events. Assumptions are necessary in such predictions so it is important to be aware of what assumptions are used in the mathematical model you design or in the mathematical models you read about.

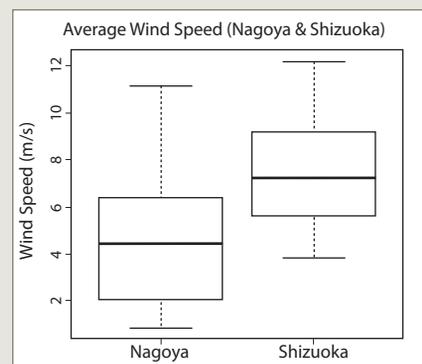
Here is some more data from the same typhoon. The map shows the trajectory of the typhoon. The boxplot shows the average wind speed at Nagoya and at Shizuoka. The chart shows the 'station pressure' (sp), the average wind speed (aws) and the maximum instantaneous wind speed (miws) as the typhoon approaches and then moves past.

1. If you are in Toyohashi, in the path of the typhoon, in which direction would you evacuate? To Nagoya or Shizuoka?
2. What information does each form of representation show especially well?

Mathematics helps us make informed decisions. Measurements can be organized in graphs and charts to enable informed hypotheses and make intelligent decisions.

	A	B	C
1	sp	aws	miws
2	999.8	3.8	6.6
3	999.4	4.8	8.9
4	998.9	4.3	7.6
5	998.8	5.0	12.1
6	998.4	4.9	13.0
7	997.8	5.0	10.8
8	997.1	4.4	10.5
9	997.4	6.8	12.7
10	996.9	6.9	16.3
11	995.8	7.2	12.4
12	995.8	8.2	17.4
13	995.4	105	16.0
14	994.4	8.9	17.3
15	994.3	7.0	16.3
16	994	5.6	16.4
17	993.6	5.1	15.0
18	993.3	6.1	16.0
19	992.9	6.0	15.2
20	992.5	6.8	16.9
21	992.2	107	23.7
22	991.8	112	24.7
23	992.1	106	23.9
24	991.8	9.2	23.9
25	991.7	102	23.7

	A	B	C
26	991.6	9.1	20.6
27	991	8.9	19.1
28	990.8	7.1	22.8
29	990.3	7.2	18.1
30	990.4	7.9	18.6
31	990.5	11.3	25.4
32	990.6	9.5	20.9
33	990.7	7.5	20.4
34	991.1	9.8	23.7
35	991.9	12.2	24.4
36	992.4	10.1	19.1
37	992.9	9.5	19.8
38	993.6	9.9	20.1
39	994.3	8.8	16.8
40	994.9	8.0	17.0
41	995.5	6.9	12.2
42	996	7.2	13.9
43	996.2	6.8	13.2
44	996.6	7.4	14.1
45	996.9	6.1	13.7
46	997.2	5.1	13.3
47	997.9	4.7	9.8
48	998.1	5.7	12.5
49	998.9	5.4	11.1
50	999.7	5.3	13.3



Sources:  
 Satellite image  
<http://weather.is.kochi-u.ac.jp/>  
 Remaining images  
<http://www.crme.kku.ac.th/apcc-thai2013.html>

In the first part of this task, students are led to think about how wind patterns and land/water formations affect rainfall. They evaluate typhoon speed by measuring distance travelled and for this they would use angles (from the latitude and longitude markers) and their knowledge of the size of the sphere (the Earth). This all requires careful

attention to units of measure. In the second part of the task, students are asked to make predictions using the mathematical modelling available to them, and to use these predictions to think about the human response to potential suffering. They will be able to see that Nagoya will be the safer refuge because of the direction of the winds

in relation to the direction of the typhoon path – the winds are greater where the circular motion is added to the typhoon trajectory, and the winds are lesser where the two motions are in opposite directions (the

Coriolis force). Students use boxplots and histograms to make statistical comparisons and they are asked to evaluate the graphs in terms of the human purpose in communication.

#### 4.5

### EXAMPLE 5

The final example in this chapter serves to help us consider the range of political sensitivity a textbook author faces. The example uses a political message from a country in which immigration is heavily politicized. The message comes from Twitter, an online news and social networking site that is used not only by the general public but by businesses to promote their services, partisan spin doctors to sway public opinion and reputable journalists to disseminate news.

Example 5 is different from the others in that it is an investigation, which means it gives relatively little direction. While some of the other examples' tasks are more investigative in nature, the other parts guide the students to give them clues about how they might go about solving the problems presented in the more open-ended elements. Example 5 leaves it up to the students to find their own data and to devise mathematical methods to communicate comparisons they are interested in promoting.

#### CONSIDERATIONS FOR TEXTBOOK AUTHORS

**5A** In the above examples, consideration 1A and others lauded the value of real data. A concern about real contexts is that they may soon feel out of date. When this chapter was written, this tweet was current and significant in a particular region. In three years' time, this message may have become relatively unimportant politically or it may have increased in significance. The instructions for students in this example, therefore, focus their attention on current

issues in their own contexts, which mitigates this problem to some extent.

**Guideline – current issues**

**5B** Any choice of context suggests that the topic is an important one for students. There are politics involved in such a choice because other issues may be more important to the students. In this example, the context is likely to be relatively unimportant in countries where refugee intake is not a political issue. Again, the task is written in a way that focuses on the general mathematical process of statistical comparisons. It leads students to work with their own social interests and apply that general process to particular, local contexts. The text's move to generalize shows that representations of proportion can be done effectively and/or dangerously in any context.

**Guideline – values**

**5C** The choice of a political hot topic may incite criticism. People may think the text too politicized for school. The text in this example is written to avoid judgments about the quotation. It does not say the quotation is fair or unfair. Instead, it invites students to make judgments based on mathematical investigation. This is what engaged citizenship looks like.

**Guideline – open dialogue**

**5D** Maths textbooks that attempt to avoid politics and culture fail to do so – they are equally political. Those apparently neutral texts actually tell students that the contexts they use are the most significant and that sustainable development and peaceful living are not important. Maths textbook authors should be ready to put forward this kind of argument to counter the inevitable criticism they will experience. Some people find change difficult to accept.

**Guideline – courage**

#### EXAMPLE 5

### Mathematical metaphors

Someone posted the following on social media: 'If I had a bowl of Skittles and I told you just three would kill you. Would you take a handful? That's our Syrian refugee problem.'

There are different ways to look at this metaphor. For example, you might ask if it is OK to compare refugees to sweets. We will focus on the mathematics of the metaphor.

1. If you assume the comparison to be proportionally accurate, investigate the statistical information you need to figure out how many Skittles are in the 'handful'.
2. Choose another risk to illustrate and compare to the risks of accepting refugees. You may choose another hotly debated political issue (for example, the dangers of handguns) or a concern that is usually ignored (for example, the dangers of driving on a highway).
3. Present your findings about the relative dangers of the two risks. Try to use metaphors like the one quoted above (a candy metaphor or something similar).
4. What are the values and dangers of using metaphors to illustrate proportion and the risks people experience daily?

## 5.0

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“ Objectivity must be a central quality of scientific observation and analysis if we are to avoid misinterpreting the facts by seeing only what we want to see rather than what is really there. However, this should not be allowed to alienate the learner or scientist from considering the wider consequences of their subject and obscure their wider role as an active citizen ”



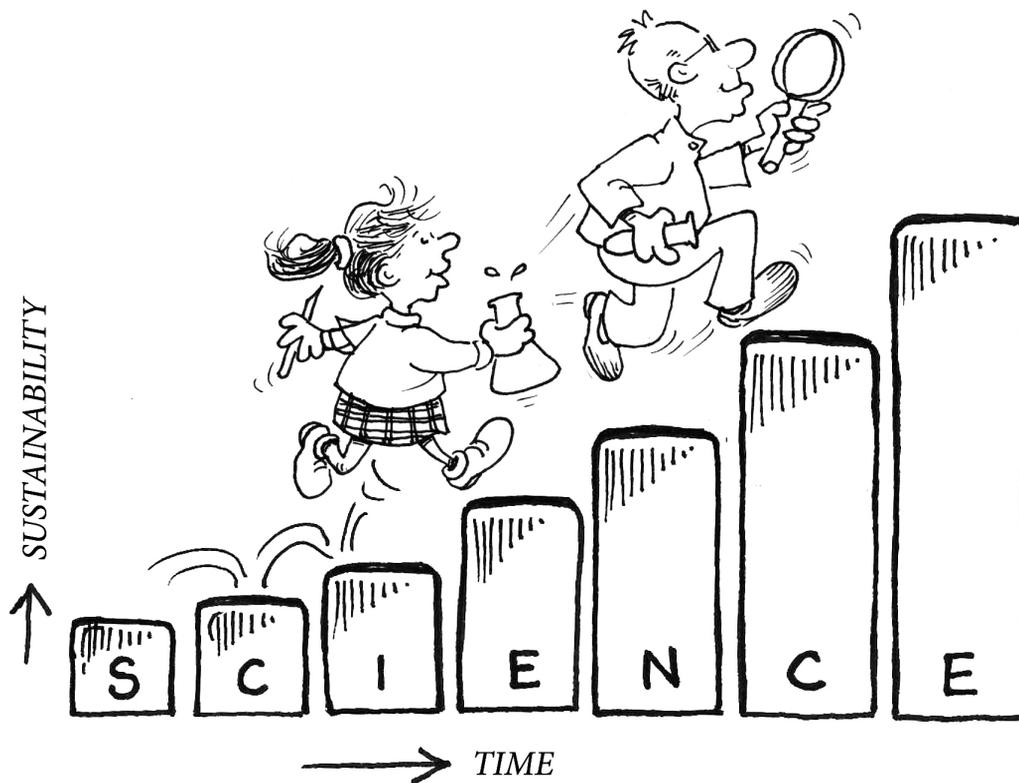
*“Objectively speaking this seems fine...  
but on past experience perhaps room for improvement!”*

# 3

## SCIENCE

<b>1.0</b>	<b>The role of science in society and sustainable development</b>	<b>67</b>
1.1	Motivation for embedding ESD into science textbook content	68
1.1.1	The need for an ethical dimension in science education	68
1.1.2	Sustainable Development Goals (SDGs)	69
1.1.3	Interconnectedness of sustainability issues	69
<b>2.0</b>	<b>Key principles to guide the embedding of ESD in science textbooks</b>	<b>70</b>
<b>3.0</b>	<b>Models and strategies for embedding ESD in science textbooks</b>	<b>74</b>
3.1	Thematic approach	74
3.2	Science, technology, society, environment (STSE) approach	75
3.2.1	Problem-based learning	76
<b>4.0</b>	<b>Examples of embedding ESD in science content</b>	<b>78</b>
4.1	Example 1: Forests	78
4.2	Example 2: Organic chemistry – plastics	82
4.3	Example 3: Physics – nuclear reactions	88
4.4	Example 4: Biology – ecosystem dynamics	94
<b>5.0</b>	<b>Final considerations</b>	<b>98</b>
<b>6.0</b>	<b>References</b>	<b>99</b>

# Building bridges between science textbooks and sustainable futures



## 1.0

### The role of science in society and sustainable development

FROM ORIGINS ROOTED in natural philosophy, the term 'science' has grown in our understanding to embrace a great range of ways of knowing about ourselves and the world around us. Relatively recently, 19th and early 20th century recognitions of specialisations such as biology, chemistry and physics have helped to define what science is and have expanded its boundaries further into many other fields and disciplines. Common to many global curricula and their supporting texts, science is often viewed as a collection of isolated facts organized into coherent topic-related blocks and dropped into textbooks as foundational material for later understanding and contextualization. These facts are, indeed, essential building blocks but it is equally important for textbooks to

recognize the role of science as a process of inquiry that uses these facts to build a comprehensive understanding of the world about us and our interaction with it and each other.

For some authors, teachers and learners, there exists an understandable confusion surrounding the association of science (education) and the social impacts associated with its application. Learners and student teachers ask, rightly, if these impacts have more relevance to the social sciences than science (education) itself. For those science textbook authors with this concern, it is worthwhile noting that science is also a social practice (Joldersma, 2009) with the same responsibilities that other social practices are obliged to honour. Thus, while this chapter focuses on textbooks for the physical sciences, in considering embedding education for sustainable development, it necessarily concerns itself with social issues that originate from their application (see sections 1.1, 2.1, 3.1 and 4.2–4.3).

The exponential application of science and science-led technologies in all fields of human endeavour

prompts a need for a greater understanding of its practise and its role in education and society. The Science Council (2009) has gone some way to providing this by defining science as ‘... the pursuit and application of knowledge and understanding of the physical and social world following a systematic methodology based on evidence’. Therefore, it is perhaps useful in the context of the approaches recommended in this chapter to consider science not just as a body of knowledge but also a process of discovery (Bruner, 2009).

It is important to acknowledge that scientific discovery and innovation have played a significant role in the general improvement of the human condition. However, the benefits of this improvement have been – and continue to be – distributed unevenly throughout the world. Science exists in a complex relationship with technology and society, and it is important to note that there have been many misguided applications of science theory and science-informed technologies. Consequently, perceptions of the role of science as a way of understanding our place in the environment, our interactions with it and each other have changed. Two progressively technologized and industrialized world wars, and unbridled mechanized resource exploitation over the past century, have caused much concern about the role and impact of applied science and technology. This has changed the perception of science from being a benign driver of human progress to being viewed as increasingly controversial, unpredictable and culpable as a result of its inability to solve many unintended consequences of its own creation. (The example presented in section 4.2 illustrates one of many such instances.)

Thus, the trustworthiness of the role of science in guiding society (and societies) is frequently (and often justifiably) held in question as its applications have become increasingly politicized and market driven, resulting in many unsustainable practices and developments (Johnston, 2013). While science per se, as defined above, should not be seen as the prime cause of this, its application in the form of many economically driven, science-led technologies can certainly be identified as leading to fundamentally unsustainable practices and lifestyles.

Thus, this chapter asks the question: how can science education reorientate the study of science and its practice towards a more sustainable future? It also proposes that a major tool for progress in this endeavour is through the skills and commitment of textbook authors embedding education for sustainable development (ESD) within subject-specific content and considers strategies for achieving this.

*How can science education reorientate the study of science and its practice towards a more sustainable future?*

## 1.1

### Motivation for embedding ESD into science textbook content

Globally, increasing dependence on science-informed technology appears to have created as many problems as it has solved. Many issues of public concern have a science dimension, referred to here and in the wider literature as socio-scientific issues (SSIs). These have an origin in applied science theory and have the potential to make a great impact on societies (Ratcliffe and Grace, 2003). In the developed world, SSIs ‘have come to represent important social issues and problems which are conceptually related to science’ (Sadler, Barab and Scott, 2007). These impacts are associated with the widespread use of economically driven, science-informed technologies applied to resource exploitation. They operate across a range of geographical scales and extend into most, if not all, aspects of human endeavour.

However, it is a mistake to think of these issues as belonging only to the developed world. These impacts extend to the most vulnerable communities, often located in countries of the developing world, frequently disrupting previously traditional and highly sustainable lifestyles (Goudie, 2005). It is clear that science and, by extension, science education make a significant impact on human-environment interactions, social and economic policies and the way that people and communities interact with each other at local, national and global scales. Thus, SSIs have a direct and vital relationship with the multiple issues associated with sustainable development (SD) and the realization of the Sustainable Development Goals detailed in the United Nations document *Transforming Our World: the 2030 Agenda for Sustainable Development* (United Nations, 2015; see also the Introductory chapter of this book). The multivariate nature of SSIs and the interconnectedness of their causes and impacts on a great diversity of global cultures presents a considerable challenge to science textbook authors. Nevertheless, it is an important guiding principle for authors to recognize that SSIs are intimately associated with embedding ESD in science content (see sections 3.0 and 4.0).

#### 1.1.1

### The need for an ethical dimension in science education

Changed perceptions of the role of science in society (see section 1.0) have highlighted the unsustainable and economically driven demands made currently by a significantly technocentric 21st-century society.

The certainties and seemingly absolute truths that science offered in the 19th and 20th centuries seem to be not so certain in the light of many negative impacts arising from its incorrect application and its vulnerability to the vested interests of sponsors for direction. To be able to address these issues, science (and science education) must first acknowledge that it does not deal solely with absolutes and that science must turn more towards the management of uncertainties and unintended consequences, frequently of its own creation.

Ashley (2000) notes this attitude as being central to citizenship education for a sustainable society, arguing that ‘... science curricula should be founded on an understanding of the limits of science and an appreciation of the fact that scientists are also moral agents who face ethical dilemmas in their work’. In considering the role of science education and science textbook authorship, fostering this moral dimension should not only apply to learners aspiring to become scientists. Only a small percentage of these learners will follow a career in applied science or become practising scientists. However, all learners will become citizens, either actively or passively sharing the responsibility for our current environmental and social impacts as well as for the well-being and sustainability of present and future generations. For active participation in society’s decision-making processes (this being the essence of active citizenship), a basic scientific literacy and the inclusion of an ethical dimension to such decisions provide a check and balance on the application of science-informed technologies and scientists’ work.

An ethical dimension embedded into science education, while clearly of benefit to the individual learner/citizen, is also a major benefit to society as a whole, enabling a capacity for critical evaluation of the complexities of SD issues. As part of this innovative approach, we propose that science education, as well as being about ‘doing’ science, should also promote critical evaluation of those social and environmental issues associated with ‘the science’ – effectively addressing what we have referred to above as socio-scientific issues (SSIs). This evolved role embraces the idea that the teaching and learning of science may foster increasing levels of understanding and communication between countries and communities for the common well-being. This moves science education into the role of informing and facilitating critical evaluation of SD issues and promoting the use of subject knowledge to develop and propose appropriate actions for the resolution of such issues.

### 1.1.2

## Sustainable Development Goals

The Sustainable Development Goals (SDGs) were

adopted by heads of state in 2015 and set the world’s development agenda up to 2030 (United Nations, 2015). Target 4.7 of the SDGs is an acknowledgement of the critical importance of education for peace and sustainable development (United Nations, 2015; see also Box 2 of the Introductory chapter). These goals are very much interdisciplinary and are not connected exclusively to any specific field. They refer to sustainable development broadly, embracing issues such as poverty, gender inequality, health education, peace and governance, as well as more commonly recognized issues such as the environment and conservation of limited resources. Thus, in using the term ‘sustainable development’, it is important to note that this is taken to refer to the full range of issues detailed by SDG Target 4.7. Although discussed in the Introductory chapter, for convenience these are reproduced below in Box 1.

### Box 1



### Extract from Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

*United Nations Transforming Our World – 2030 Agenda for Sustainable Development*

Target 4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development.

### 1.1.3

## Interconnectedness of sustainability issues

Considering the interconnectedness of SD issues, science (and by implication science education) should not be perceived as a singular approach to understanding our interactions with the world and each other. Rather, it is more accurate to regard science as one aspect of a multidisciplinary attempt to make sense of and understand the world in which we live. Moving towards this integrated outlook, many science education policies and curricula

have promoted – and continue to promote – interdisciplinary links between science, technology, engineering and mathematics (STEM). In doing so, they seek to broaden the scope of understanding by aligning the traditional sciences (biology, chemistry and physics) with the fields of mathematics, technology and engineering.

While such initiatives are praiseworthy, there remains the danger of exclusivity in STEM relationships with other subject areas, which defeats the point of a holistic understanding of SD issues and appropriate actions to address them. It is a mistake to think of these combined fields existing independently from other disciplines and wider social influences, particularly from segments of society driven by political and economic priorities. STEM initiatives tend to be driven by demand for essential skills defined by politically and economically motivated actors. They are vulnerable to national and multinational vested interests, which may be incompatible with SD. Science research follows research funding and, in this respect, funding is a great determinant of the focus, goals and nature of science education.

Therefore, it is useful for the science textbook author, who is approaching embedding ESD, to be aware

of the socio-economic and associated political drivers that may influence curriculum content and so detract from the centrality and importance of sustainable development issues. While this observation does not directly offer practical advice on how to embed ESD, it does contribute insights to help with mining curricula for opportunities to integrate science subject knowledge with the wider social impacts of its application.

SD issues are complex and fostering an awareness in learners of these wider issues by embedding ESD into science curricula is essential for equipping a new generation of ‘citizen-scientists’ (Wals et al, 2014) with effective tools for understanding and addressing the fundamental nature of these issues. Since the content of most science textbooks is guided by the requirements of national curricula, this chapter aims to support science textbook authors in identifying curriculum opportunities for embedding ESD within required science topics. The advice offered here focuses on embedding ESD into textbooks while still supporting the requirements of current science curricula. In the interest of maintaining a focus on textbook authorship, it leaves for another time the discussion of the merits of a fully integrated curriculum that embeds ESD.

## 2.0

# Key principles to guide the embedding of ESD in science textbooks

In many contemporary societies, there is a gap between aspirations for a sustainable future and practical solutions for achieving this. Embedding sustainability issues into science curricula and textbooks is an important step towards developing the skills and understanding required to promote such a future. Achieving this while maintaining the integrity of the role of the textbook in developing and transferring subject knowledge is a considerable challenge.

*In an increasingly science-driven age, with unprecedented access to great volumes of information, a basic scientific literacy becomes essential*

The selection of content in response to curriculum requirements is complex and embedding ESD adds another layer of complexity to science textbook authorship, particularly for those authors new to sustainability concepts and issues. Even for those authors well versed in SD issues there will be differences in perception, prioritization and contextualization arising from diverse cultural backgrounds and specialization. The multivariate nature of the issues defined by the term ‘sustainable development’ (see section 1.1.2) and the wide-ranging cultural backgrounds of the potential readership (and authors!) necessarily means there can be no single recipe for embedding ESD into science content. Nevertheless, there are many over-arching principles that may serve as a guiding framework. The Introductory chapter identified a series of generic principles for embedding ESD. Box 2 (opposite) identifies nine key guiding principles that support embedding ESD into science textbook content. Supporting references as an additional resource are also noted and fully sourced in the reference section at the end of this chapter.

Many of the principles noted in Box 2 engage with the entire range of issues defined by the umbrella term ‘sustainable development’. However, some principles may not be able to be explored by some subject material so may be passed over under these circumstances without detracting from the aims of ESD. The approach finally adopted should ideally take into account the interconnectedness of the issues and the interdisciplinary nature and potential of a fully integrated curriculum.

**Box 2****Principles to support the embedding of ESD in science textbook content**

1. Connect ‘issue-centric’ ESD to curriculum-based textbook formats and assessment frameworks (*Church and Skelton, 2010*).
2. Introduce subject content and skills in the context of science, technology, society and environment (STSE) relationships (*Stratton et al, 2015; Azeiteiro et al, 2014; Johnston, 2009*).
3. Ensure issues are defined and discussed in local contexts, taking into account learners’ experiences and cultural identities while remaining connected with global impacts and consequences (*Stibbe and Luna, 2009*).
4. Promote critical evaluation of issues from multiple viewpoints (*Warren, 2014; Wiek, 2011*).
5. Identify and contextualize SSIs (such as environmental degradation and social conflict arising from the management of scarce resources) that can trigger deeper social injustices arising from unequal access to resources and opportunities (*Sipos, 2008; Veugelers, 2000*).
6. Expand global awareness by promoting whole-systems thinking (*Meadows and Wright, 2008*).
7. Encourage learner-centred research to explore STSE relationships and use its findings to inform social actions and address SSI and STSE problems (*Dietz et al, 2003; Bäckstrand, 2003; Blumenfeld, 1991; Thomas 2000*).
8. Unpack the language of science into a more accessible and contextualized form that takes into account the impacts and consequences of the use of scientifically informed technologies (*Bybee, 2002; Rampal and Mander, 2013*).
9. Emphasize the interconnectedness and multivariate nature of SD issues by fostering curricular and cultural links between subjects and communities to enhance mutual understanding and communication (*Tilbury, 2011; Cohen, 2002*).

## The role of the science textbook in embedding ESD

### Principles 1, 2, 4 and 6

Currently, science textbooks orientate towards delivering information that is largely designed to introduce learners to ‘how science works’ and ‘how to be scientists’. This is clearly important for the welfare and greater benefit of society overall (consider the discussion of STEM in section 1.1.3). However, it is not every learner’s aim to become a scientist. Consequently, science education should be obliged to provide more than simply career opportunities. In an increasingly science-driven age, with unprecedented access to great volumes of information, a basic scientific literacy becomes essential to make this information meaningful. Only then can the learner function as an active citizen and participate in society’s decision-making processes. Thus, science education (and, by implication, science textbooks) must extend well beyond the role of simply producing scientists. In this respect, embedding ESD in science textbooks informs our interactions with each other and the impacts we make on the environment. Above all, it enables active citizenship for the development of a more sustainable future by underpinning and supporting teaching and classroom initiatives for embedding ESD in science curricula.

## Selection of content

### Principles 1 to 9 inclusive

The material presented in science textbooks in general does not change very radically from year to year. In the main, content remains the same and the science has been ‘done’, is ‘tried and tested’ and, most likely, will remain the same at all levels of study for some time to come. The exception to this is when major discoveries invalidate current dogma and experience. However, the perspective taken in the presentation of topics is always open to change and, in the current context, this is exactly what needs to be achieved in favour of ESD. Embedding ESD into content should encourage learners to manage their own learning goals by developing their awareness of the wider consequences and impacts of the uses and applications of science in society. The science textbook should provide foundation information. However, it must also develop a capacity for learning and thinking strategies that take into account different perspectives, value the opinions of others and enable actions as globally aware citizens.

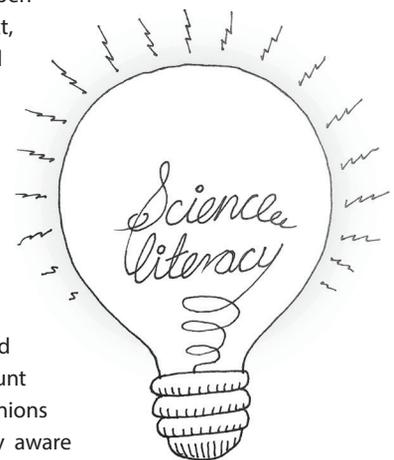


Table 1: Advisory dos and don'ts for embedding ESD in science topics

✗ ESD SHOULD NOT ...	✓ ESD SHOULD ...
... be a series of bolt-on case studies used solely to enhance science teaching by providing a context for the material being taught.	... be embedded within topics using subject knowledge to make associations with and to explore SD issues.
... be merely an additional commentary using examples that have no direct engagement with the learners' real-life experiences.	... enable recognition of the interconnectedness of SD issues, applied science and technology and the impacts these make on societies locally and globally.
... be written about/taught as a separate subject or series of isolated concepts or topics.	... enable recognition of the interconnectedness of issues and applied science to stimulate discussion and debate to inform lifestyle choices that may positively influence both the individual and society.
... present negative sustainability issues as the inevitable consequence of fast-evolving scientific development.	... recognize that learners are (future) citizens, who have rights and responsibilities to participate in decision-making processes. It should emphasize the need for a basic scientific literacy to support this at individual and social levels.

## Critical thinking – evaluation/objectivity

### Principles 1, 2, 3, 4 and 7

Case studies in science textbooks are frequently used to contextualize learning. However, it is rare that science textbooks explicitly facilitate learners' understanding of social dilemmas associated with scientific development and science-informed technologies. There exists an understandably natural fear of overlap with the social sciences. For those with this concern, it is worthwhile considering science as a social practice (without diluting the strengths of the scientific method) (Joldersma, 2009). Evaluation of socio-scientific issues invites value judgments and this is not the norm in science textbooks, which promote objectivity as a central axiom of scientific methodology. This can be uncomfortable for teachers, learners and all those who define science solely in terms of objectively derived conclusions.

Objectivity must be a central quality of scientific observation and analysis if we are to avoid misinterpreting the facts by seeing only what we want to see rather than what is really there. However, this should not be allowed to alienate the learner or scientist from considering the wider consequences of their subject and obscure their wider role as active citizens. To summarize Joldersma (2011), while there is such a thing as an objective reality, 'this cannot be perceived objectively, since it is mediated by our own lenses'. It is these lenses that the ESD-

conscious textbook author should aim to exercise and strengthen while retaining the advantages of objective analysis. It is a considerable challenge for authors to support learners in becoming proficient in the detail of their subject while fostering such skills. Nevertheless, one of the main goals of embedding ESD in science texts should be the development of this capacity for critical evaluation of SSIs, their impacts and implications through the lenses of the learners' experience (section 3.2).

## Use of inclusive and accessible language and ESD perspectives

### Principle 8

Many science textbooks are written in an authoritative style that 'informs' the learner and presents facts and definitions in an unquestioning manner. This approach of 'delivering' a body of information to a learner is aligned to a behaviourist perspective of learning, which contrasts with a constructivist approach, where learners are encouraged to engage and make sense of a theme, thus actively 'constructing' their knowledge. A constructivist style arouses curiosity, helps learners explore and make connections with their own experiences, ask questions, look for tentative explanations in their own language, discuss and come to conclusions collectively (see section 3.2). The style of writing a text or presenting a theme depends on how authors

*Objectivity must be a central quality of scientific observation and analysis if we are to avoid misinterpreting the facts by seeing only what we want to see rather than what is really there. However, this should not be allowed to alienate the learner or scientist from considering the wider consequences of their subject and obscure their wider role as active citizens*

perceive learning to happen and it is important that authors are sensitive to how learners think about a concept and what alternative preconceptions learners may have. A lack of this sensitivity can result in science 'definitions' being merely reproduced but not understood.

Research into learners' 'alternative frameworks' or 'intuitive ideas in science' (Driver, 1985, 1994) can help authors appreciate how various science concepts (often routinely stated in textbooks) are counter-intuitive for learners to understand. Textbooks need to address learners' intuitive ideas creatively and provide structure for their progression. For instance, children (and even adults!) have trouble understanding that we stand on the surface of a spherical planet that is spinning and that those on the opposite side stand 'upside down' and yet do not feel dizzy or fall off. Children as they develop may go through a progression of ideas, from a flat earth with limited sky on 'top' and an absolute view of 'down', to a spherical earth surrounded by sky with 'down' being towards its centre. The challenge for authors is to trigger their imagination and thought to change their intuitive notions. To embed ESD, therefore, it is even more important that textbooks reflect a nuanced understanding of learners' conceptions across a wide spectrum of concepts. Moreover, where learners' conceptions arise from entrenched social or religious beliefs, the language and perspectives of the textbook play a crucial role in allowing a dialogic engagement with scientific concepts (Rampal, 1994).

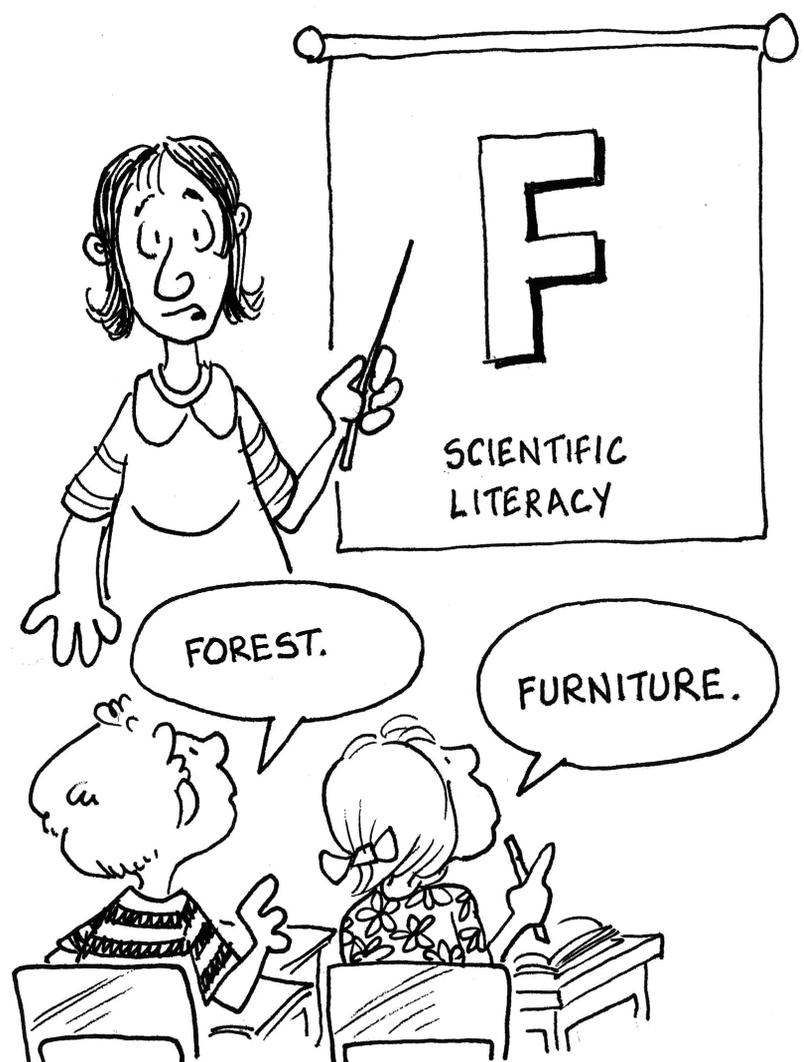
Presenting science not as absolute truth but as an ongoing process of knowledge construction fosters an appreciation of how scientists have grappled with ideas. Instead of cursorily including a technical 'bio-sketch' of a scientist or coldly presenting theories and models, a more human story located within its socio-cultural and historical contexts allows learners to connect with the process. It also indicates to them that their own intuitive ideas in science are a continuation of the process of observing and making sense of the world around them, which humans have been doing for centuries.

The language of science textbooks can be impersonal, distant and transactional. This does not help communication or learning (especially for young learners) and inhibits their own expressions and feelings, discouraging their active engagement and compelling them to memorize statements. A more expressive and personally engaged style that reflects uncertainties, curiosity, amazement, excitement, adventure, frustrations and humour helps to relate to learners and supports their understanding of complex ideas (Rampal, 1992). The use of alienating technical terms in elementary science textbooks unnecessarily confounds the process of making meaning for learners (Sutton, 1992; Rampal, 2008). This is especially true when the language of the textbook adopts terminologies that have no live

connections with people's knowledge and spoken registers (see section 4.1).

The Official Languages Commission of India (Government of India, 1956), which grappled with the development of technical vocabularies for a nation of vast linguistic diversity and low literacy, wisely advocated that scientific terms for the official Indian languages should not be artificially 'concocted' as a literary exercise. Rather, it proposed that terminologies be drawn from the vocational and colloquial knowledge of artisans and technicians and their own personally derived hybrid forms of technical terminologies. This was rejected by language purists with the consequence of alienating and excluding large numbers of children because popular and colloquial lexicons disappeared from the language of textbooks. Thus, a language for learning that identifies with, connects with and evokes empathy among young learners with a great diversity of cultural identities, environments and 'ways of knowing' is most effective for embedding ESD in science textbooks. Section 4.1 considers further these contrasting perspectives and writing styles and also provides an example of good practice to support effective ESD.

*Instead of cursorily including a technical 'bio-sketch' of a scientist or coldly presenting theories and models, a more human story – located within its socio-cultural and historical contexts – enables learners to connect with the process*



3.0

# Models and strategies for embedding ESD in science textbooks

The three approaches below are strong tools for embedding ESD into science textbook content.

- 1) A thematic approach, which links SD issues to curriculum content.
- 2) A science, technology, society and environment (STSE) approach, which makes clear connections between science content and SD issues.
- 3) A problem-based learning (PBL) approach.

It is important to note that these three approaches are not mutually exclusive and it is more useful to consider how they complement each other to inform the embedding of ESD rather than to look for differences between them. In fact, the thematic approach (1) and problem based-learning approach (3) are as effective as extensions of the STSE approach as they are in isolation.

Sections 3.1 and 3.2 clarify what each approach has to offer and detail how they contribute individually and together to the effectiveness of embedding ESD in science texts. Ultimately, it is not a matter of choosing one approach over another and textbook authors should feel able to ‘mix and match’ according to the demands of the subject being addressed. Examples of their application follow in sections 4.2 to 4.4.

3.1

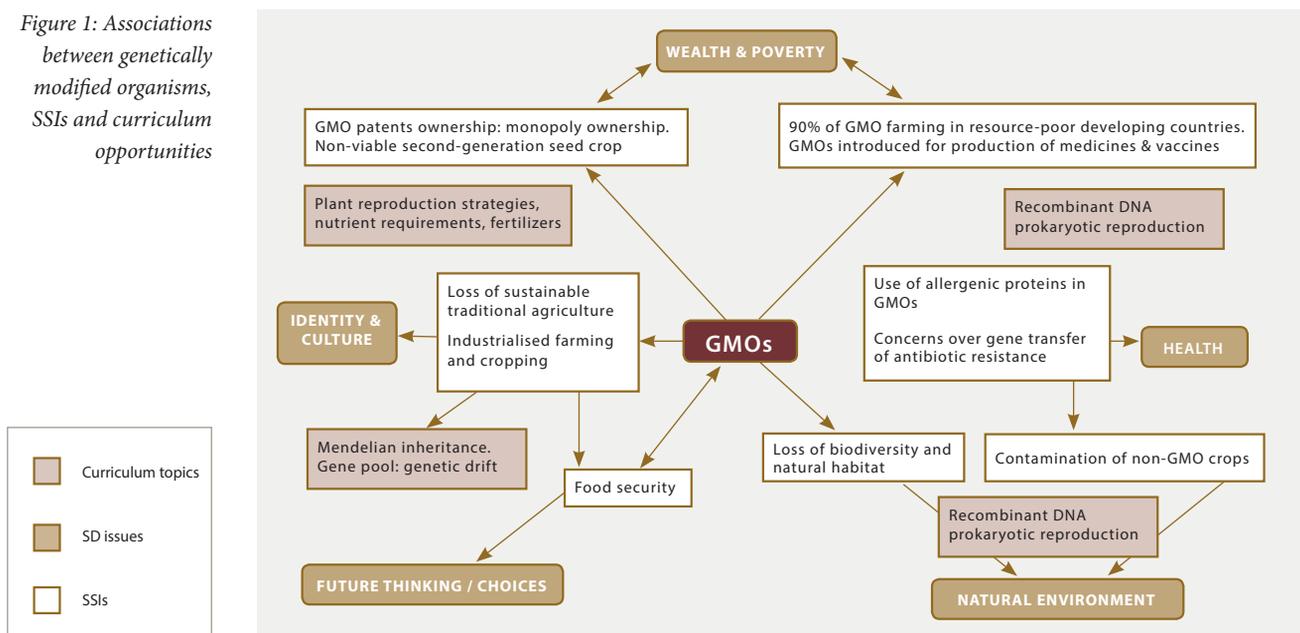
## Thematic approach

Most science textbooks are non-thematic in nature. They are structured linearly, governed largely by curriculum considerations that tend towards blocks of learning. These blocks are usually organized in a sequence aimed at providing foundational knowledge for later higher-level study. SD issues are rarely addressed in context, other than as case studies to aid subject learning or as interesting asides. Few demands are made of learners to research or contextualize the issues for themselves. This is understandable since, in the context of current educational priorities, the major emphasis is on acquiring subject knowledge.

A thematic approach to science textbook authorship can present the science as the central anchor, mapping aspects of the topic against SSIs and curriculum requirements (sections 4.2 and 4.3), or can be issue-centric, where the issues play a major central role and the science of the topics being studied is used to explore them (section 4.3).

Figure 1 illustrates a tool for thematic embedding. The science topic ‘genetically modified organisms’ (GMOs) is the central anchor. The interconnectedness of a range of SSIs is mapped against a selection of curriculum opportunities.

Figure 1: Associations between genetically modified organisms, SSIs and curriculum opportunities



It is important that such a mapping closely follows the learning outcomes associated with the syllabus and the age group of the learners. Particular attention is paid to this in the examples presented in sections 4.2 to 4.4, where specific learning outcomes are identified and used to guide the selection of the material being presented.

Opportunities for embedding ESD in this template centre on the biology of genetically modified organisms, a key topic of many curricula, although chemistry (at certain grade levels) may be appropriate for inclusion as well. Mining biology curricula more thoroughly on the basis of Figure 1 identifies detailed components such as DNA, protein synthesis, neo-Darwinian genetics, antibiotic resistance, ecosystem dynamics and the biological impact of monocultures. Of course, these suggestions are indicative and there are many other possibilities depending on the syllabus being approached and the focus of the textbook chapter/section.

Initially, this may appear to suggest that issue-centric learning takes precedence over curriculum material. However, this is not the intention because adopting a thematic approach serves the dual purpose of relating curriculum topics to each other (rather than addressing them in isolation in a linear manner) while associating them with SD issues as an integral part of knowledge transfer.

Templates such as Figure 1 can be adapted to any science topic that illustrates associations between the application of science-led technologies and their associated social impacts. As well as being a guide for authors, templates such as these can be used by learners to evaluate both positive and negative associations between the science being learned, its application and its potential impacts. However, it is not sufficient to identify the culpability of applied science and technology, it is also vitally important to explore science's potential in addressing these issues in a positive manner.

For example, in Figure 1 the impacts and consequences associated with this technology are provided for the reader. However, an alternative presentation might be to leave these areas open to be responded to as part of personal research, encouraging learners to identify for themselves and evaluate critically the consequences and propose informed actions on the basis of their own scientific analyses. At this point, the textbook embedding ESD can propose an open structure and provide resources for debate to explore the nuances of the issues identified.

In summary, thematic approaches are effective for embedding socio-scientific issues, identifying these as global concerns and emphasizing the interconnectedness of their impacts and causes. Having identified these associations (Figure 1), the textbook author (or indeed the learner as noted

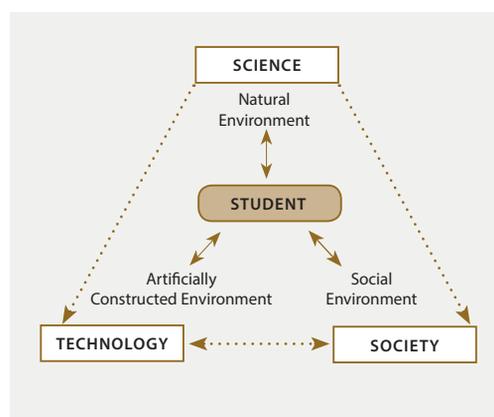
above) can explore SD issues that extend beyond the science and make a global and local impact on current and future societies, countries and ecosystems.

Clearly, this has the potential to offer an extensive array of associations that lend themselves to engaging with other topics within the science curriculum and wider interdisciplinary associations. However, we acknowledge that the major brief given to most textbook authors is that of knowledge transfer defined by the requirements of a given curriculum within the confines of a particular subject. Nevertheless, we do not believe that this is an insurmountable barrier preventing authors from the central task of 'teaching science' while taking note of the principles noted in Box 2. Section 4.0 provides examples to explore these challenges.

### 3.2

## Science, technology, society and environment (STSE) approach

Many textbook authors will be familiar with the STSE approach to science education. Nevertheless, it is useful to redefine it here in the current context. Although they evolved separately, the underlying principles are constructivist in nature and relate closely to those presented in section 2.1 (Box 2). Figure 2 summarizes this model for science education that emphasizes teaching science in its cultural, economic, social and political contexts (MacLeod, 2015; Pedretti and Bellomo, 2013; Aikenhead, 2006). In this approach, pupils and students are recognized as being complex learners whose living experiences can be incorporated into the learning and teaching process and used as a starting point for embedding ESD. Section 1.1 identified learners as 'future citizens and decision makers in science and technology', who will bring about change in future societies. However, learners do not always see themselves like this, often feeling disconnected from the substance and concepts presented in current curricula and learning environments (Pedretti and Bellomo, 2013; Aikenhead, 2006; Korfiatis, 2005).



*Thematic approaches are effective for embedding socio-scientific issues, identifying these as global concerns and emphasizing the interconnectedness of their impacts and causes*

Figure 2:  
STSE teaching model

Source: 'What is STS science teaching?' Aikenhead (1994) in STS Education: International Perspectives on Reform, Teachers College Columbia University

*The ultimate goal of the STSE approach (and its application to embed ESD into science texts) is to foster an understanding of the wider impacts of applied science and technology and so enable actions for achieving a sustainable future*

Section 1.0 also noted how science has traditionally been regarded as a body of knowledge based on objectively assessed phenomena. This has greatly influenced the manner in which scientific knowledge is transferred to learners, that is, by neglecting to take into account how they experience science and technology on their own terms. Although usually applied to teaching practice, this has much relevance to science textbook content. Heavily content-based science curricula (and, by association, textbook support for this) are often remote from learners' everyday experiences and fail to take into account how content is related to real-life problems.

The STSE approach addresses this issue by ensuring that SSIs and other SD issues have an integral and relevant role in the material being presented. Figure 3 maps these relationships showing SD/SSIs occupying the central domain of the graphic. Understanding the nature of these issues and associating them with curriculum material should be the main aim of textbook authors using this approach. An outline sequence is shown below:

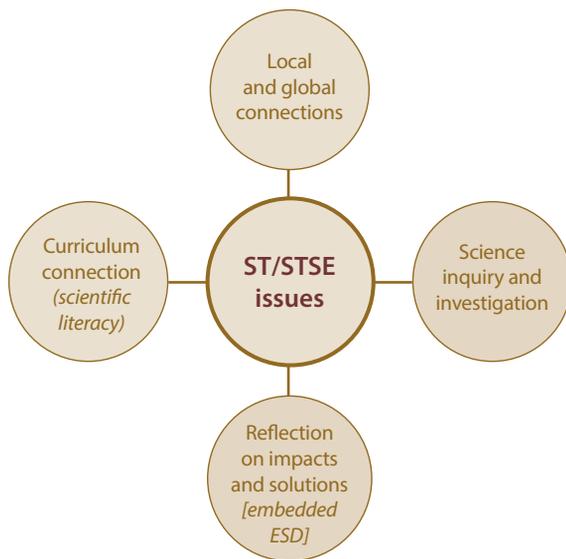


Figure 3: Generic STSE model showing relationship of key domains for embedding ESD

Five domains are identified:

- 1) SD issues and SSIs are explored as the central focus in this process.
- 2) Local and global connections are considered.
- 3) Curriculum connections are made (scientific literacy).
- 4) Science inquiry and investigation are used to inform (domain 5).
- 5) Pupils reflect on and propose potential solutions and actions for implementing them.

Together these result in ESD being embedded by creating a framework of background knowledge for 'inquiry and investigation' to 'identify local and global contexts' while 'maintaining close connections with curriculum requirements'.

The ultimate goal of the STSE approach (and its application to embed ESD into science texts) is to foster an understanding of the wider impacts of applied science and technology and so enable actions for achieving a sustainable future. Embedded ESD should encourage learners to reflect on the issues and their attitudes toward them. SD issues need to be connected to learners' own lives to encourage meaningful reflection and informed actions. By taking this approach, learners are encouraged to understand how their lives are connected to science, technology and society. They can then become active decision-makers and problem-solvers, advised by their knowledge of science and informed by their personal worldviews (Johnston, 2002).

Constructivist perspectives on the nature of learning are founded on how people make sense of their experience. Consequently, they have much to offer the discussion of embedding ESD in science textbooks. Authors wishing to explore these perspectives further should see *Constructivism as Educational Theory: Contingency and Learning, and Optimally Guided Construction* (Taber, 2011).

3.2.1

### Problem-based learning

Problem-based learning (PBL) aligns well with the thematic and STSE approaches discussed above (see sections 4.2 to 4.4 for examples). The fact that project-based learning and problem-based learning share the same abbreviation can be the source of some confusion. Project-based learning originated in medical schools as 'competency-based learning' around 1949 (see Frank et al, 2010). Problem-based learning may be seen as a progression of this, posing real-world problems using case studies. For our purposes, the difference is largely semantic with some minor operational distinctions. Table 2 summarizes the similarities and differences in the approaches and associates these with the ESD key principles presented in Box 2.

Table 2: Project-based learning versus problem-based learning properties associated with ESD principles (see Box 2)

PROJECT-BASED LEARNING	PROBLEM-BASED LEARNING
<i>Similarities</i>	
<ul style="list-style-type: none"> <li>• A focus on open-ended questions/evaluations.</li> <li>• The capacity for issue-centric applications of content and skills.</li> <li>• Both build 21st-century success skills (future thinking).</li> <li>• Both emphasize learner independence and inquiry (research-informed action proposals).</li> </ul>	
<i>Differences</i>	
Multi-subject.	Usually single subject.
May use scenarios. These often involve real-world, fully authentic tasks and settings.	Uses case studies or fictitious scenarios as problems.
Includes creation of a product that is tangible or abstract as a performance.	Focuses on a proposed solution in writing or as a presentation.

Problem-solving contexts have been recognized as effective ways to develop learners' cognitive reasoning, social knowledge and communication and decision-making skills in science education (Hmelo-Silver and Barrows, 2008; Kim and Tan, 2013). An interactive setting for solving problems provides a context in which learners can make claims, negotiate and integrate different types and levels of evidence and knowledge and look for solutions to socially relevant questions. PBL provides fertile ground for embedding ESD in the form of a story or scenario (see section 4.4). While this is particularly – although not exclusively – effective for early-stage learners (Harris and Katz, 2016), it is easily adapted for middle- and high-school students (see section 4.4).

At the end of a given topic, embedding authors may also find this a useful self-check for the learner – assessing their own understanding of both the substantive science being taught as well as the embedded SD component(s). Data analyses, analysis of media articles and scientific appraisals of science-related projects and applications, which have relevant connections with learners' living experiences, are all baseline resources available to textbook authors. Useful further information on this approach can be found in Larmer (2015) and Savery (2015).

#### IN SUMMARY

- **STSE approach.** Embedding ESD into science topics can be enhanced greatly by aligning the issues discussed (SSIs) with real-life experiences relevant to the learner audience.
- **PBL approach.** This should encourage active rather than passive learning by providing the stimulus for analysis, debate and the proposal of research-informed solutions.
- **Thematic approach.** Embedding ESD should develop science textbooks as an important resource and reference point for supporting learners and teachers by contextualizing their understanding of the science being studied and the socio-scientific and sustainable development issues associated with its application.

Figure 4 draws together these three approaches, revealing how the thematic approach integrates with the STSE approach to explore the interconnectedness of issues. It shows PBL as a means of actively engaging the learners' attention with SD issues and the scientific knowledge being presented.

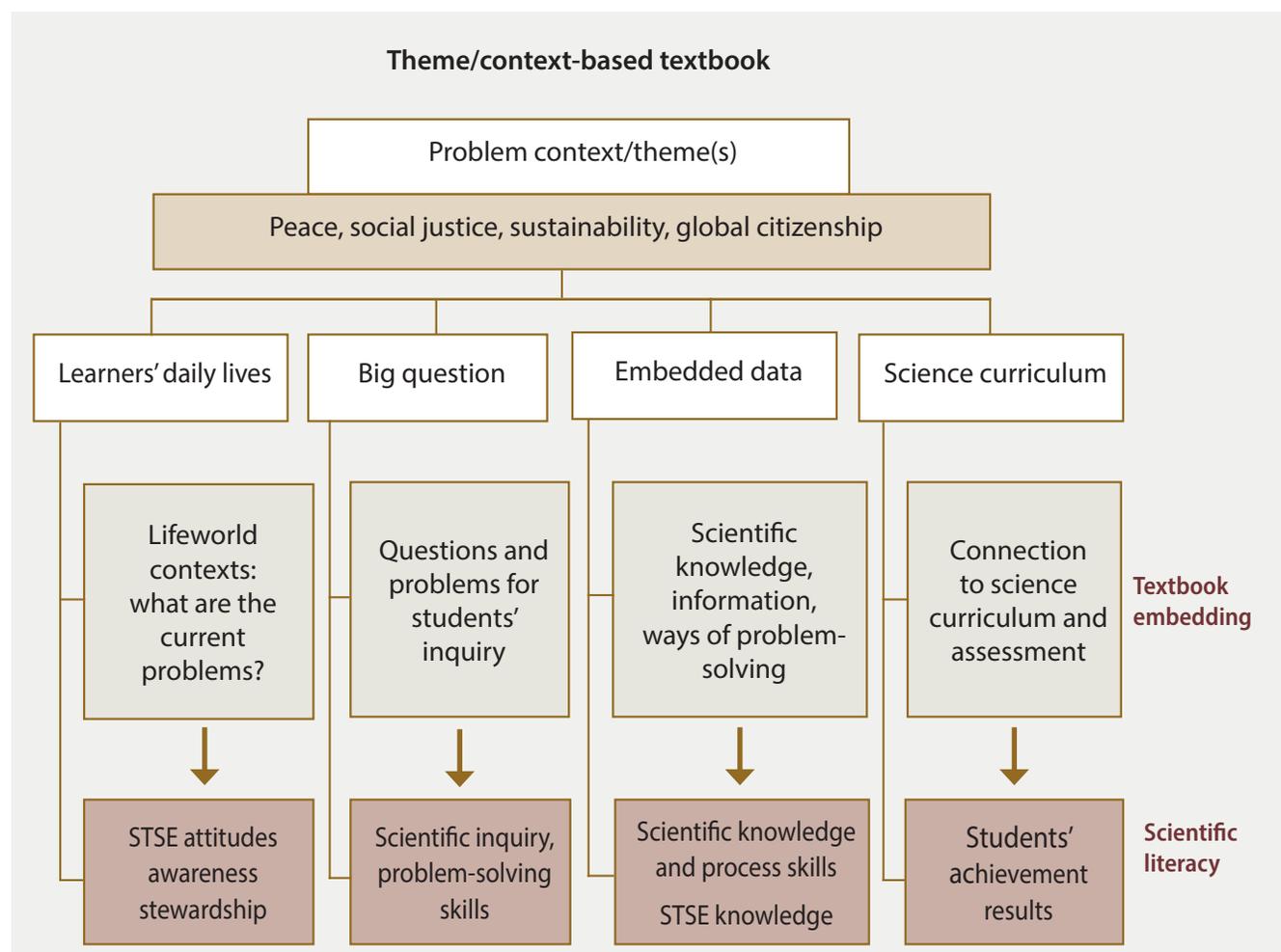


Figure 4: Integration of approaches discussed in sections 3.1 and 3.2

## 4.0

## Examples of embedding ESD in science content

The following sections provide curriculum-based examples with advisory commentary to support the embedding of ESD in science texts. These examples are not intended as recipes but are outline approaches. They give authors scope to customize, taking into account differing curricular requirements, personal specialist skills and the diverse cultural identities of the readership (and authorship!).

Understanding and accommodating learners' modes of communication and perceptions of the world is essential to be able to explore value-laden sustainability issues and associated SSIs. Section 4.1 builds on the considerations of language style and author perspectives put forward in section 2.0 and provides a comparison of approaches and an example of good practice using a recognized textbook. This operates at elementary/primary level, however, the principles remain the same at more advanced levels.

Sections 4.2 to 4.4 provide original examples closely integrated with learning outcomes from a range of curricula as a guiding template for authors approaching embedding ESD. The importance of making strong links with curriculum learning outcomes, while also engaging with learners' real-world perceptions and experiences following a constructivist ethic, has already been emphasized. The examples presented in sections 4.2 to 4.4 consider how this can be achieved by applying the strategies discussed in sections 3.1 to 3.3.

## 4.1

### Topic: Forests – use of inclusive and accessible language and ESD perspectives

#### Principle 8

Most science textbooks adopt a utilitarian perspective and approach to communicating science content. Their modes of communication are frequently perceived as remote, with few 'real' connections and little personal engagement with the learner.

Forests and forest management are common topics in curricula worldwide but perceptions of their importance to our well-being and our interactions with them vary widely. It is useful to consider contrasting perspectives in dealing with this subject at primary-level science (biology) as an exploration of good practice in the context of ESD (see section 2.0).

Typically, mainstream textbooks approach this subject by regarding forests as economic resources. One such (elementary) Grade 5/6 extract promotes an understanding of forests as valuable resources for lumber, rubber, fruits, pulp and other commodities. Having established this outlook, the textbook then emphasizes the commercial and economic perspective of large-scale employment:

*'There are over 300 million hectares of forests in the United States ... Many forests are located on public land. Others are owned by individuals, private timber and paper companies. Forest industries in the US*

*provide jobs for more than one million people. Because new trees can be planted to replace tress cut down, forests can be renewable resources.'* (Padilla, 2006).

The text then considers different methods of logging – showing diagrams of chainsaws, clear cutting and selective cutting – leading to replanted or diverse tree growth. Although sustainability is implied as a consideration of the outcome of selective felling, this is not the main thrust of the presentation and wider issues of sustainability and the learners' role in this are not addressed.

The rhetorical question is then posed: 'Why else are forests important?' with the response 'Because they produce oxygen, absorb pollutants, and help prevent flooding and control soil erosion.' This sentence is not a simple 'statement' but involves several abstract and difficult concepts. How 'forests produce oxygen' or 'absorb pollutants' are complex ideas which, although taught later in the syllabus at more advanced levels, are usually not understood at primary level.

These are anthropocentric perspectives and the complex concepts are introduced prematurely. They do not enhance the personal relationship between the subject being studied and the learners' 'lived-in' experiences, cultural identities and environments.

A contrasting example is the chapter provocatively titled 'Whose forests?' from the Grade 5 textbook on Environmental Studies (EVS) in India (NCERT, 2008, Chapter 20, p. 182). EVS is the integrated form of teaching science and social studies at primary level (Grades 3–5). Box 3 provides an excerpt from the National Syllabus for EVS (NCERT, 2006, p. 94).

**Box 3****Excerpt of foreword from National Curriculum Framework 2005 (NCERT 2006)**

*'Conventionally biologists divide living things broadly into two categories 'plants' and 'animals'. The idea of 'plants' is considered simple enough to be presented in primary school along with 'parts of a plant', 'functions of the parts of the plant', etc. But why should this (reductionist) way of looking at a plant be considered more 'natural' or even desirable for a child? In fact, extensive research across the world has shown that young children find it too abstract to make a distinction between living and non-living, or to divide the living world between plants and animals ... This has led some primary school curricula to postpone these conventional categories and first allow space to children to explore their own intuitive ideas, in order to achieve a better understanding later, of how science tends to classify them differently ...*

*'(In this syllabus they learn about 'plants' as connected to people, within the larger theme of 'Family and Friends') so in Class IV they look at 'flowers' and flower sellers, or discuss 'who trees belong to?', while in Class V they move on to 'forests and forest people', the notion of parks or sanctuaries, and ... in this way they are enabled to construct a more holistically connected understanding, from a scientific, social, cultural and environmental perspective, that is enriched with an aesthetic and caring appreciation of plants around them.' (NCERT, 2006, p. 94)*

The National Elementary Syllabus document (NCERT, 2006, p. 127) underpinned by this framework consciously embedded an ESD perspective into EVS. The following example chapter, 'Whose forests?', was developed around the key questions for the sub-theme 'Forests and forest people' in this syllabus:

*Have you seen or heard about a forest?*

*How do people live in forests?*

*How is their life being threatened by forests being cut?*

*Have you heard of a park or sanctuary? Who looks after it?*

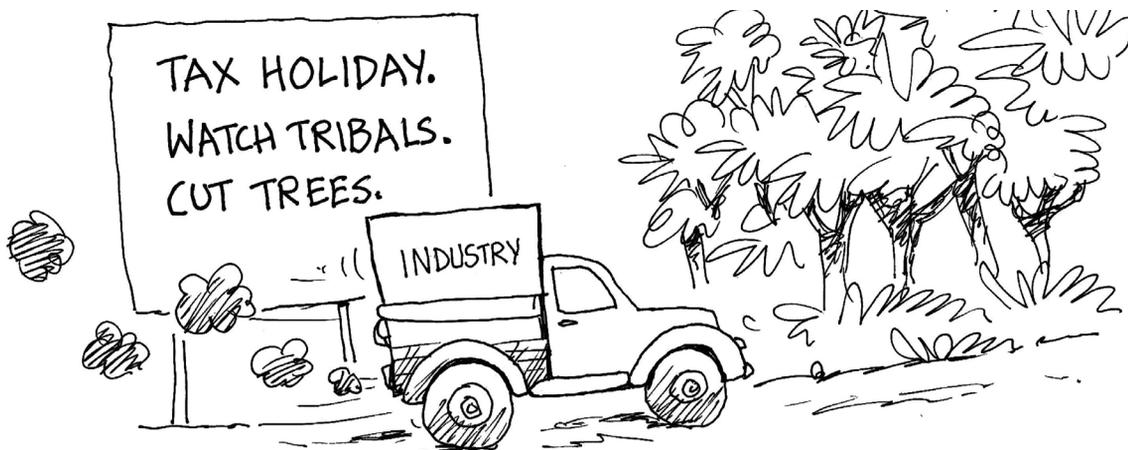
*Does anybody own it?*

*Have you seen a place where trees are worshipped or protected by the villagers?*  
(NCERT, 2006, p. 127)

Box 4 (overleaf) shows the opening page of this chapter. It begins with the true story of a woman protagonist. Suryamani, who belongs to the indigenous Kuduk-speaking community of forest dwellers in the state of Jharkhand, strives to protect the forest and her community's local knowledge. Learners consider forests through the eyes of the community, their collective wisdom and their perennial struggles through a 'pedagogy of empathy' (Rampal and Mander, 2013).

**Advisory note for authors**

*'Real-life' documents, such as personal letters, historical travelogues, biographies, family records and oral narratives, are an effective means of personalising subject content. Similarly, instead of using typical illustrations of disembodied hands holding instruments, textbooks can include an array of visuals that reflect an engaged multicultural human presence. A textbook page designed as a dynamic visual text can speak to learners and arouse their interest more effectively than cold and authoritative science text.*



## EXAMPLE 1

### Forests

#### Elementary Grade 5

Box 4

‘Whose forests?’ Grade 5 (NCERT, 2008, latest reprint 2016)

Suryamani says:

‘To learn to read the forest is as important as reading books.’ She takes young children every week to the forests to know themselves: ‘We are forest people. Our lives are linked to the forest. If the forest is not there we too will not remain.’

## 20. Whose Forests?

### Daughter of the jungle

Look at the picture. Where do you think these children are off to, with little bundles on their sticks? When you find out you too would want to go with them!

The children are going to the forest. There they jump, run, climb trees and sing songs in their language called Kuduk. They pick the fallen flowers and leaves, to weave them into



necklaces. They enjoy the wild fruits. They look for birds, whose calls they imitate. Joining them in all this fun is their favourite *didi* – Suryamani.

Every Sunday Suryamani takes the children to the forest. As they move around, she shows them how to recognise the trees, the plants, and animals. Children enjoy this special class in a forest! Suryamani always says, “To learn to read the forest is as important as reading books.” She says, “We are forest people (*adivasis*). Our lives are linked to the forests. If the forests are not there, we too will not remain.”



Suryamani’s story is a true story. Suryamani is a ‘Girl Star’. ‘Girl Stars’ is a project which tells extraordinary tales of ordinary girls, who have changed their lives by going to school.

**Teacher’s Note :** Encourage children to share their experiences and imagination about forests. Planting thousands of trees does not make a forest. It is important to discuss the web of relationships between plants, trees and animals in a forest, to see how they depend on each other for food, security and habitat.



182

#### Teachers’ note

There should be debate on the need for – and impacts associated with – the building of big dams, roads, mining projects, etc. It is important for learners to discuss and understand that all of these – drawing out water, oil or extracting minerals from under the ground, or commercial fishing from the seas – are examples of using our ‘common resources’. All these are important issues today (NCERT, 2008, p. 185).

What do you think is a forest?  
 What else is there other than trees?  
 Why does Suryamani say: 'If forests are not there, we too will not remain'?  
 The contractor did not allow Suryamani's people to go into the forest. Why?  
 Is there any place around your area which you feel should be open to everyone, but where people are not allowed to go?  
 Who do you think the forest belongs to?

The language of this textbook consciously invokes a true narrative of human agency to present the life-long struggle and drama of saving forests, not merely as 'management of forests' as a decontextualized 'techno-scientific' issue. Different actors relate what forests mean to them, while the text invites learners to think about their concerns.

#### Advisory note for authors

*In this text, the following questions for children do not emphasize 'definitions' but encourage them to construct their own understanding from the critical insights of Suryamani and her people.*

The indigenous people's sustaining wisdom of common resources is shared without the need to sermonize on the conservation of natural resources. It is worth noting that once natural resources are introduced as a commodity for human exploitation, it then seems to be contrary to speak of 'conserving' them.

Suryamani's uncle Bhudhiyamai says:  
 'Forest is our "collective bank" – not yours or mine alone.'  
 Are there other things which are our collective wealth?  
 So if someone uses more, everyone would suffer?

#### Right to Forest Act 2007

People who have been living in the forests for at least 25 years have a right over the forest land and what is grown on it. They should not be removed from the forest. The work of protecting the forest should be done by their Gram Sabha (village body/local self government).

This textbook opens a debate on political issues, making students think about notions of development and reminding them of the major Right to Forest Act 2007.

Reflection and informed actions are also encouraged in the same academic context, leading with an original letter written by a Grade 10 learner from a tribal community to the chief minister of her state.

Sikhya, a Class X girl in Orissa, wrote a letter to the chief minister. Read a part of the letter.

*'A forest is everything for us adivasis. We can't live away from the forests even for a day. Government has started many projects in the name of development – dams and factories are being built. Forests, which are ours, are being taken away from us. Because of these projects, we need to think where the forest people will go and what will happen to their livelihood. Where will the lakhs of animals living in the forests go? If there are no forests, and we dig out our lands for minerals like aluminium, what will be left? Only polluted air, water, and miles and miles of barren land ...'*

The above comparison and example of good practice shows how the topic of forest ecosystems can be handled in two very different ways. The more conventional approach treats forests as 'resources for human consumption', enunciated through a style of information delivery that is largely impersonal and transactional. In contrast, 'Whose forests?' embeds the perspective of sustainable development and social justice in the text. By using a range of language styles and registers in the narratives of different people, records such as the Forest Law and a student's letter, 'Whose forests?' invokes the agency

of human engagement to nurture students' empathy. While language style and register are referred to here in an Indian context, they have the ability to resonate strongly with a global readership embracing a great diversity of cultural identities, environments and 'ways of knowing'. For textbook authors engaged in embedding ESD, this is a useful reminder that appropriate language register and style can be important tools for connecting with and developing learners' desire to make associations between subject-specific content and wider sustainability issues.

## 4.2

**Topic: Organic chemistry – plastics manufacture and uses**

**APPROACH:** Thematic and problem-based learning (sections 3.1 and 3.2.1)

**STEP 1 Identifying learning outcomes**

This example addresses sustainability issues associated with the manufacture, disposal and recycling of plastics. The learning outcomes associated with this example are taken from the Welsh Joint Education Committee (WJEC) General Certificate of Secondary Education (GCSE) for ages 14 to 16 (2016) and Advanced Level (A Level) in Chemistry for ages 16 to 18 (2015). Boxes 5 and 6 detail the learning outcomes that underpin this example and also show how ESD learning outcomes may be associated with those referring to subject-specific content.

**STEP 2 Developing a theme and identifying curriculum opportunities for embedding**

For the organic chemistry of plastics topic, an appropriate central theme might be 'an alternative understanding of plastics as a renewable resource'. Section 3.1 discussed the value of using a schematic mapping tool (Figure 1) to identify associations between curriculum specifications, SSIs and wider SD issues. Figure 5 shows the application of this tool to explore curricula for opportunities for embedding ESD in this aspect of organic chemistry.

This approach has the dual advantage of identifying associations between science content and SD issues while also mining the curriculum for opportunities for embedding ESD into a given topic. The subject knowledge – in this case, organic chemistry – can then be used to associate many interconnected SD issues with the manufacture, use and disposal of plastics.

**Box 5****Extract of learning outcomes for the WJEC GCSE in Chemistry (2016)**

## 2.5 CRUDE OIL, FUELS AND ORGANIC CHEMISTRY

Learners should be able to apply and demonstrate their understanding of:

Learning outcomes:

1. The fractional distillation of crude oil.
2. Fractions as containing mixtures of hydrocarbons (alkanes) with similar boiling points.
3. The cracking of some fractions to produce smaller and more useful hydrocarbon molecules, including monomers (alkenes), which can be used to make plastics.
4. Addition polymerisation of ethene and other monomers to produce (plastics) polythene, poly(propene), poly(vinylchloride) and poly(tetrafluoroethene).
5. The general properties of plastics and the uses of polythene, poly(propene), poly(vinylchloride) and poly(tetrafluoroethene).

**Suggested ESD learning outcomes**

Learners should be able to:

1. Critically evaluate the positive and negative aspects of the manufacture and use of plastics.
2. Use the knowledge of cracking in polymerization to compare renewable alternatives with oil as the resource for manufacturing plastics.
3. Use the knowledge of organic chemistry to recognise that what society currently designates as rubbish can be redefined as a resource and suggest actions to fulfil this.

**Advisory note for authors**

*The examples in the following sections (sections 4.2 to 4.4) are not intended as exhaustive treatments of curriculum requirements. Key learning outcomes from current curricula have been selected as being indicative of opportunities for embedding ESD. It is hoped that the prospective textbook author may note how opportunities have been identified and expanded upon and will find this a useful guide to forays into similar curriculum material.*

**Box 6****Extract of learning outcomes for the WJEC A Level in Chemistry (2015)**

## TOPIC OA 1: HIGHER CONCEPTS IN ORGANIC CHEMISTRY

Learners should be able to apply and demonstrate their understanding of:

Learning outcomes:

1. Structure of and bonding in benzene and other arenes.
2. Resistance to addition reactions shown by aromatic compounds such as benzene.
3. Mechanism of electrophilic substitution, such as in the nitration, halogenation and interaction between benzene and substituent groups, as exemplified by the increase in C–Cl bond strength in chlorobenzene when compared with a chloroalkane.
4. Nature of addition polymerization and the economic importance of the polymers of alkenes and substituted alkenes.

**Suggested ESD learning outcomes**

Learners should be able to:

1. Use their knowledge of structure and bonding in benzene and other arenes to propose new approaches to recycling.
2. Use their knowledge of cracking of hydrocarbons to compare renewable alternatives with oil as the major source for manufacturing plastic.
3. Assess the potential impact on the environment of the by-products of biodegradable plastics.

Plastics fulfil many essential and beneficial roles in learners' daily lives. While there are many serious negative unsustainable impacts associated with the manufacture and use of plastics, it is important to acknowledge the positive influence they have had on our lives. Benefits such as anatomical implants/prosthetics, electrical insulators, food storage and preservation have become essential to individual lives and whole societies. For this reason, authors should note that Figure 5 identifies positive associations (in yellow text on the right) as well as negative associations (in red text on the left) and emphasizes that it is not the existence of plastics that is problematical but the manner of their use and disposal.

As part of an extended curriculum, strong links may be made to other areas of study, such as:

- Environmental sustainability (biology/chemistry and ecosystem studies).
- Economic sustainability (economics/long-term viability of resources).

'The fractional distillation of crude oil to produce hydrocarbons' and 'nomenclature and structure of hydrocarbons' are two topics that are common foundation concepts in many organic international chemistry curricula at this level. The detail of the following example assumes that learners are already familiar with these concepts. It builds on this foundation to introduce the chemical processes of addition and condensation polymerisation, addressing the learning outcomes noted in Boxes 5 and 6 using the subject-specific content as a lens through which to develop embedded ESD.

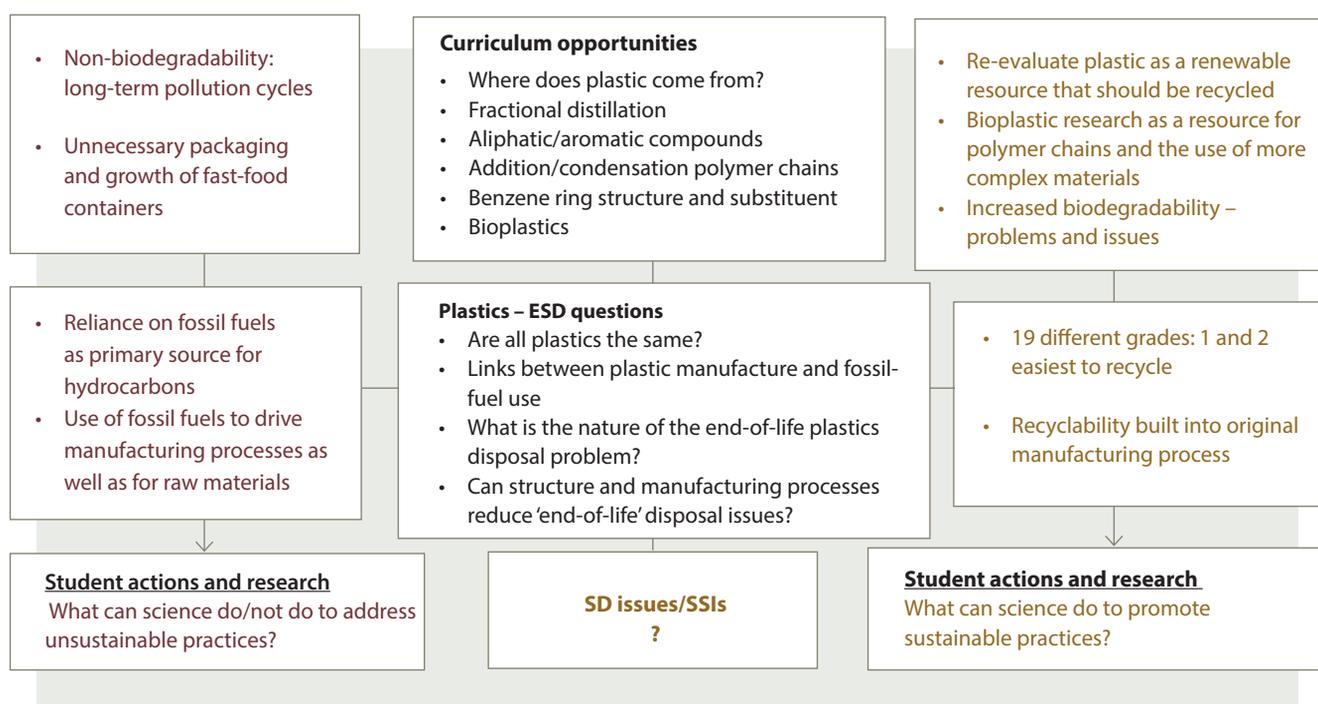


Figure 5: Framework to identify curriculum ESD opportunities and issues

## EXAMPLE 2

### Organic chemistry – plastics manufacture and uses

#### Organic chemistry: aromatic compounds, polymers and plastics

*'an alternative understanding of plastics as a renewable resource'*

##### Advisory note for authors

*The opportunity to embed ESD here is to consider what alternatives to oil might be used as source material in the manufacture of synthetic plastics (see Box 5, learning outcomes 1–5, ESD learning outcomes 1 and 2).*

Most plastics at the molecular level consist of chains of hydrocarbons (polymers) derived from the fractional distillation of crude oil. Although natural polymers, such as rubber, have the properties of some synthetic plastics, most plastics in use today are manufactured using oil as a source of hydrocarbons. Plastic bags, bottles and food cartons are made of petrochemicals, harvested from oil by fractional distillation. The plastics industry uses nearly 5 per cent of the world's oil supply. Oil is a limited and non-renewable resource and, as a result, current plastic manufacture and use may be seen as unsustainable with many interconnected SSIs.

<b>ESD question</b>	How can chemistry address the sustainable use of plastics made from fossil fuels?
<b>Science question</b>	Use the internet to learn about polymers made from bioplastics – how do they differ from polymers made from oil?

##### Advisory note for authors

*Asking ESD questions at this point enables learners to use their developing knowledge of the chemistry underpinning the manufacture of plastics to understand the questions more fully and to consider potential solutions to the problems posed.*

The polymers used to manufacture plastics have been an area of rapid research and development, shaping many consumer patterns and lifestyle choices. Great benefits have been gained from their use in surgery, food hygiene, building and construction, electronics and flight – including space flight. While there are negative issues associated with the development of modern plastics, these benefits must be acknowledged in any consideration of their role in society.

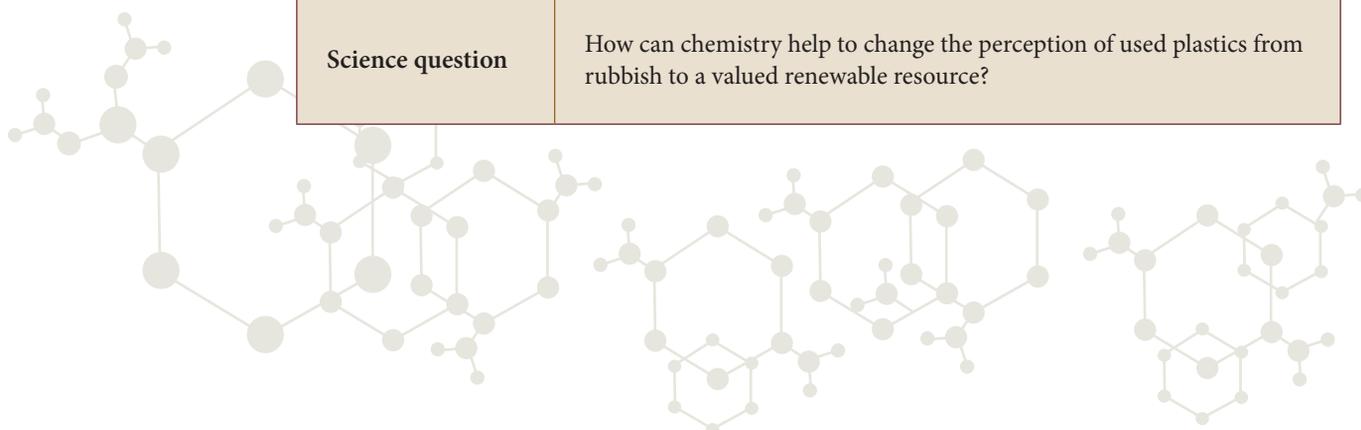
The negligent disposal of plastic waste and its persistence in the environment is a problem that overshadows the benefits of plastics usage. Its robustly non-biodegradable properties present a long-term problem on a global scale.

Recyclability and biodegradability are two major issues. When one tonne of plastic bags is reused or recycled, the energy equivalent of 11 barrels of oil is saved. When regarded as rubbish to be thrown away, plastic bags are a waste of a valuable, non-renewable resource.

##### Advisory note for authors

*The opportunity for embedding ESD here is to associate recycling and biodegradability with the chemistry of plastic manufacture (see Box 5, learning outcome 5, ESD learning outcome 3; and Box 6, learning outcomes 1–4, ESD learning outcomes 2 and 3).*

<b>ESD question</b>	What are the environmental, health and social problems associated with current attitudes towards the disposal of used plastics?
<b>Science question</b>	How can chemistry help to change the perception of used plastics from rubbish to a valued renewable resource?



## Hydrocarbons and polymers

Aliphatic hydrocarbons are linear chains that may have branches with substituent atoms or molecules attached. Aromatic hydrocarbons are cyclic hydrocarbons that may contain a benzene ring and may also form part of a chain. Repeating sequences of these chains are called polymers. There are two major forms of polymerization presented at this academic level: 1) addition polymerization and 2) condensation polymerization. These form the building blocks for the manufacture of plastics.

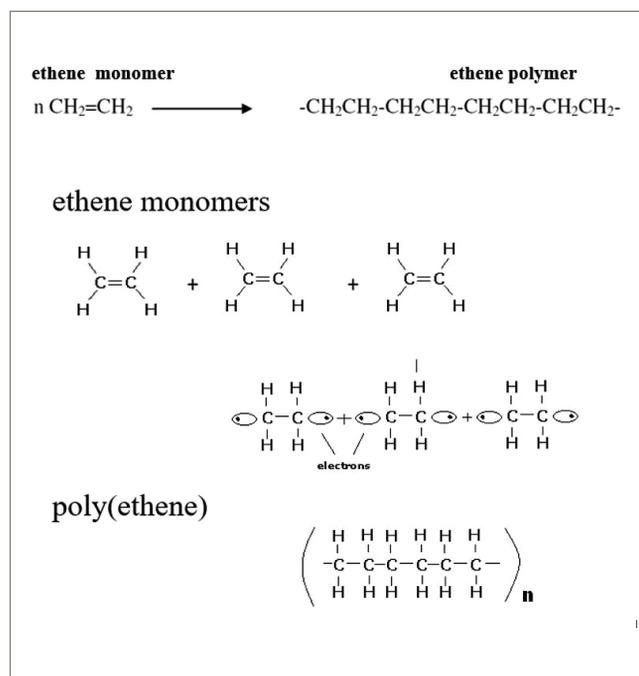
Polythene – Low Density Polyethylene (LDPE)  
(recycling no. 4)

Uses: flexible wraps; rubbish and rubble bags

High Density Polyethylene (HDPE)  
(recycling number 2)

Uses: drinks bottles, containers for soft foods such as margarine, grocery bags

The simplest addition polymer, polyethylene is an unbranched aliphatic polymer composed of thousands of  $-\text{CH}_2-$  units (monomers). Ethene is formed by a free radical addition reaction. Polyethethylene (polythene) polymerization occurs because two monomers are added to each other, with elimination of a double bond in the monomer.



### Advisory note for authors

As a foundation for the future consideration of recyclability, the chemistry of the substitution of atoms of different elements into addition polymers to form plastic polymers (such as PVC polyvinyl chloride or PP polypropylene) should be introduced at this point. In other words, we are setting up the chemical foundations for evaluation of sustainable practices, such as recyclability and biodegradability.

When an atom of chlorine is exchanged for an atom of hydrogen in an ethene monomer, the resulting addition polymer is polyvinyl chloride (PVC) (Figure 6). If chlorine is then substituted for a methyl group ( $\text{CH}_3$ ), this results in polypropylene and the recycling number increases to 5 (see Table 3, which associates the ease of recycling common polymers). The substituted molecules can produce toxic by-products that limit recycling processes.

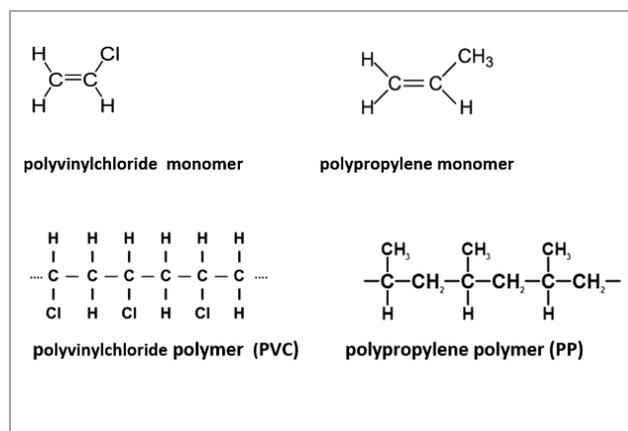
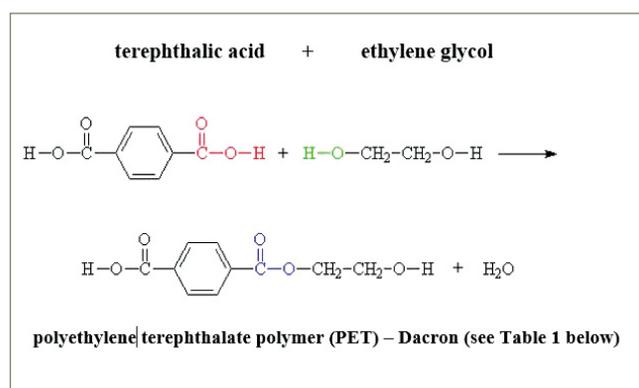


Figure 6: PVC and PP monomers and addition polymers

## Condensation polymerisation

Condensation polymerization involves condensing two monomer units together, formed by the elimination of a water molecule once the monomers are linked. Dacron is a polyester polymer polyethylene terephthalate (PET). It is formed when ethylene glycol (an alcohol) reacts with terephthalic acid (a carboxylic acid) to form an ester bond, ejecting a water molecule in a condensation reaction.



This type of condensation polymer combines small molecules that contain A units (terephthalic acid) and B units (ethylene glycol), which are joined in sequence, such as -A-B-A-B-A-B-. The ease with which plastics can be recycled depends on how easy it is to reclaim constituent polymers back to useful monomers leaving a non-toxic by-product. The type of bonding and constituents of polymers greatly influence how easily they may be recycled/reprocessed or transformed into a new product. Table 3 provides an index of the recyclability and recycling options most commonly adopted.



ESD question	Why might it not be possible to recycle some plastics safely or easily? Apart from chemical aspects, (discuss) what other factors might limit/prevent effective recycling?
ESD question	Use Table 3 to research what ‘end of life’ options exist for dealing with those plastics that cannot be recycled?
Science question	Why do you think PET has a recycling number of 1?
Science question	Why do PVC and PP have two recycling numbers (3 and 5 respectively)? What chemical factors cause this reduction in recyclability?

### Biodegradability and bioplastics

A third of all plastic is designed to be thrown away (with an expected usefulness of less than one year). The economics of plastic production support this unsustainable approach – it is inexpensive to produce and durable so is frequently designed without any thought of its reuse.

The problem has been worsened by the global trade in cheap commodities – driven by low wages in economically vulnerable parts of the world – as well as an insatiable appetite among consumers in developed and emerging economies for bottled water, elaborate packaging and ‘cheap and cheerful’ goods such as toys.

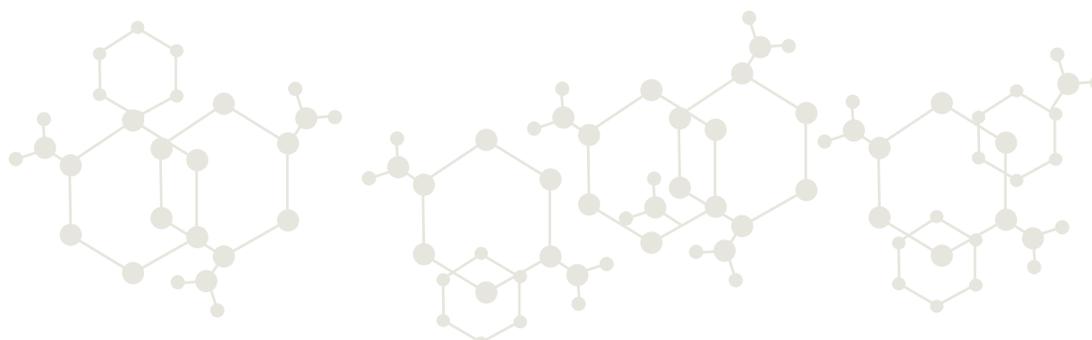
To be biodegradable, a material has to be capable of decomposing naturally through exposure to microorganisms. Biodegradation requires polymer chains to be broken into fragments small enough for microorganisms to act upon them. Petroleum-derived plastics do not exist in nature. Consequently, there are no microorganisms naturally adapted to decomposing them. Polyethylene polymers do not biodegrade since long chains of  $-CH_2-$  groups are almost impervious to microorganisms.

Bioplastics are made from polymers refined from plant material, such as corn starch, and are biodegradable. A common bioplastic is polylactic acid (PLA).

Science question	Research the structure of polylactic acid (PLA). What makes this biodegradable?
ESD question	Drinks bottle manufacturers now replace 30 per cent of the petroleum-derived ethanol in normal PET plastic with bio-derived ethanol. This does not make it biodegradable. Why not? How does this make plastic manufacture and use more sustainable?
Science question	What are weak sites in a polymer chain? How might the C=C bond be considered a weak site? How do weak sites contribute to biodegradability?
ESD question	How might weak sites be built into the manufacturing process?

#### Advisory note for authors

*The science and ESD questions above are designed to integrate subject-specific content with SD issues and the problems are designed to seek out potential solutions to the issues through the lens of the subject knowledge gained. For example, the question about how bio-derived ethanol contributes to sustainability through its inclusion in PET polymers requires the student to think about how petroleum-based resources such as ethanol are conserved by replacement with a bio substitute.*



## 4.3

**Topic: Physics – nuclear reactions**

**APPROACH:** STSE and problem-based learning (calculation/discourse) (see sections 3.2 and 3.2.1)

**STEP 1 Identifying learning outcomes**

This example addresses sustainability issues associated with the curriculum topics nuclear reactions, radiation and nuclear decay. It employs the STSE approach, supported by problem-based learning in the form of calculations and integrated subject specific/ESD questions. Box 7 provides the curriculum-specified learning outcomes that underpin the example, drawn from WJEC GCE A Level in Physics (2016).

**Advisory note for authors**

*To fully integrate the two sets of learning outcomes noted in Box 7, it is important to establish a good understanding of the properties of radioactivity and radioactive particles. Learners who have undertaken calculations of the longevity of radiation in the environment will then have the ability to undertake an informed evaluation of the socio-scientific and sustainability issues associated with the role of nuclear energy. The STSE approach enables such an evaluation by presenting a range of opinions from sources in the public domain (see below).*

**Box 7**

**Extract of learning outcomes for the WJEC General Certificate of Education Advanced Level:**

**A Level in Physics ages 16–18 (2016)**

Learners should be able to apply and demonstrate their understanding of:

Learning outcomes:

1. The spontaneous nature of nuclear decay; the nature of  $\alpha$ ,  $\beta$  and  $\gamma$  radiation and equations to represent the nuclear transformations using the  $A/Z X$  notation.
2. Different methods used to distinguish between  $\alpha$ ,  $\beta$  and  $\gamma$  radiation and the connections between the nature, penetration and range for ionising particles.
3. How to make allowance for background radiation in experimental measurements.
4. The concept of the half-life,  $T_{1/2}$ .

**Suggested ESD learning outcomes:**

Learners should be able to:

1. Assess the role of nuclear energy as a component of sustainable development.
2. Undertake an informed risk/benefit comparison of nuclear versus fossil fuels for long-term energy security.
3. Understand the importance of inter-generational issues associated with radioactive waste disposal.
4. Assess the role of nuclear energy as a component of sustainable development.

## STEP 2 Identifying curriculum opportunities for embedding

Figure 7 explores the curriculum learning outcomes to identify opportunities for embedding ESD in this aspect of physics. It has been noted earlier in this chapter that a major role of ESD is to inform debate and foster critical evaluation of SD issues, prompting decisions and actions. Therefore, in Figure 7, nuclear energy appears on both the negative and positive sides of the chart, indicating the uncertainty surrounding the issue.

The nuclear issue differs from many other SSIs in that decisions and actions surrounding it are almost entirely controlled by government interests for security (nuclear weaponry) and economic factors.

This has clear implications for a number of SD issues at local, national and global scales, such as international social equity, environmental protection and the maintenance of peaceful relationships as well as energy security and the economic well-being of populations. Nevertheless, knowledge and application of nuclear reactions provide tools and techniques to treat cancer and undertake diagnostic and therapeutic radiotherapy. Many other benign applications of nuclear technology can be identified. The contrasting nature of these two very different applications of the science emphasizes the need for greater evaluation of the sustainable development issues associated with nuclear science for safeguarding the present and ensuring future well-being.

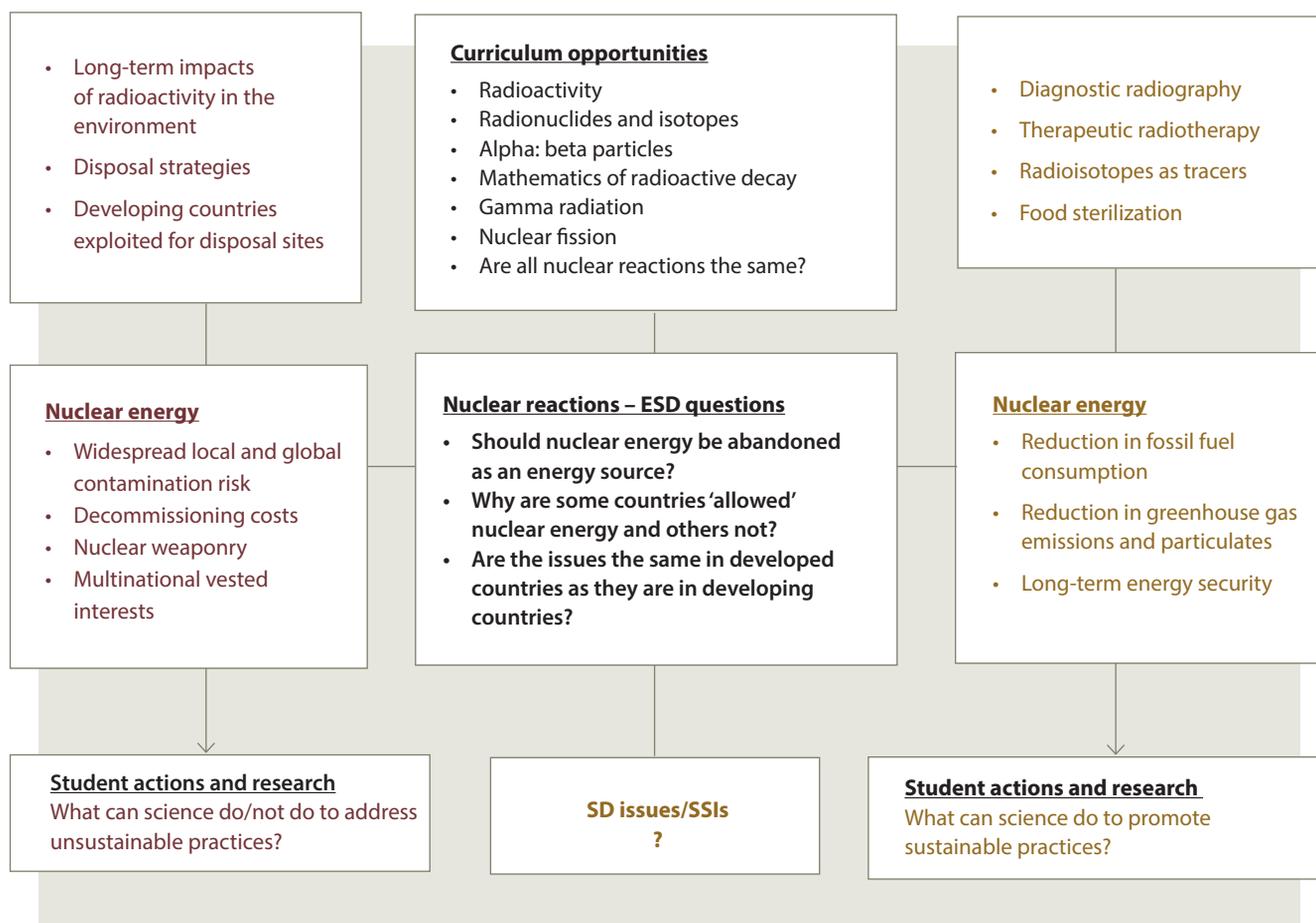


Figure 7: Framework to identify curriculum ESD opportunities and issues

### Advisory note for authors

Associated with all these issues is the control that some nations have in deciding which countries can access nuclear science and development. It is important to note that any limitation placed on the access to such technology also limits the positive benefits for those societies. The role of ESD in this context is to promote critical evaluation of the facts and enable informed participation in decision-making processes associated with nuclear science. This example aims to encourage students to apply their understanding of nuclear reactions to evaluate the risks associated with nuclear energy production. Physics learning outcomes 1, 3 and 4 are addressed in the opening sections of this example and ESD learning outcomes are fulfilled in the later sections.

## EXAMPLE 3

### Physics – nuclear reactions/nuclear energy

#### Radiation (radioactive decay)

The term 'radionuclide' refers to an atom that is unstable and undergoes radioactive decay into another new element. Radioactive decay (radioactivity) is the process by which the nucleus of a radionuclide loses energy by emitting radiation.



Material that spontaneously emits such radiation is considered radioactive. Nuclear radiation consists of alpha ( $\alpha$ ) particles, beta ( $\beta$ ) particles (high-energy electrons) and gamma radiation.

#### Alpha ( $\alpha$ ) particle radiation (decay):

particles consist of 2 protons and 2 neutrons (a charge of 2+, and mass of 4 amu.) noted as,  ${}^4_2\alpha$  or  ${}^4_2\text{He}$  because they are the same as a helium nucleus. Decay results in a new element being formed.

**Example** – Radon decays into polonium when it emits an alpha particle. Here is the equation for that radioactive decay:



**Impact on living tissues:** Alpha particles are slow, have a short range in air and can be stopped by a sheet of paper. However, their mass and speed makes them capable of substantial ionisation and in contact with human tissue they cause much more damage than other forms of radiation.

**Beta ( $\beta$ ) particles:** High-energy, fast-moving, negatively charged electrons ejected from the nucleus to balance the loss of protons.

**Example:** Carbon-14 is a radioactive isotope of carbon (*a carbon atom with 8 neutrons instead of the usual 6*). Here is the equation for the beta decay of carbon-14 into nitrogen.



**Impact on living tissues:** Beta ( $\beta$ ) particles have a longer range and more penetrating power than alphas. They can cross the skin barrier into cells directly but ionize much less strongly so cause approximately 1/20th of the damage to tissues as the same dose of alpha particles.

**Gamma radiation:** Very high frequency electromagnetic radiation, emitted by nuclei in an excited state in the form of electromagnetic waves. It has no mass or charge.

**Impact on living tissue:** Gamma rays do not lose much energy as they travel because they do not interact to the same extent with the matter they pass through. Gamma rays have a high penetrating power and a very long range. They can interact with cells in the body to make them non-functional and can cause mutations and malfunctions in DNA.

#### Half-life

The activity of radioisotopes decreases exponentially with time. After a given time period, the amount that has yet to decay is halved. The time taken for this halving of activity is called the 'half-life' – the point at which half of the original material will have decayed.

Calculate the half-life for uranium-238

Example calculation  $T_{1/2} = (\ln(e) \text{ decay constant}) / \ln(0.5)$

Rates of decay vary and may be predicted mathematically according to the expression:

$$N_t = N_0 * e^{-kt}$$

$N_t$  = number of atoms

$T$  = time

$N_0$  = number of atoms at  $t_0$

$k$  = decay constant (provided)

Substituting for uranium-238 results in a half-life of  $4.5 \times 10^9$  years (4,500,000,000 years)

Whereas:

Polonium-212 only has a half-life of  $3 \times 10^{-7}$  seconds (0.000 000 3 seconds).

So ! half of the uranium-238 in existence now will still be here when the sun dies!

### Nuclear energy generation and sustainability

'Nuclear energy is recognized as being carbon-free technology for energy production. CO<sub>2</sub> emissions between 5–7 g per kW/h compared with coal 900 g per kW/h. The waste produced can be effectively stored and local leakages are minimal and global effects are limited. Conversely, nuclear power stations are viewed by others as accidents waiting to happen – if not in the near future then certainly at some point in the very distant future.' (Rowe, 2017, pp 34–41).

**Student activity:** Consider the statements above and present your evaluation in the light of the following calculations.

Science question	What is enrichment?
Science question	Weapons-grade enriched uranium-235 comprises 0.72 per cent isotopic abundance of uranium used in nuclear reactors, which is used for enrichment as fuel and nuclear weapons. Calculate the half-life for this element. (Answer: 704 million years!)
Science question	Plutonium-239 can be enriched more easily in the reactor of a nuclear power plant. Calculate the half-life of this radionuclide. (Answer: 24,110 years.)

### Advisory note for authors

The following exercise adopts an STSE scenario to provide a platform for debate and evaluation of the viability of nuclear energy. The articles come from different cultural backgrounds (the USA and India). This exercise addresses ESD learning outcomes 1–4 (Box 7), underpinned by curriculum learning outcomes 1 and 4. Other countries and regions, such as Chernobyl and Fukushima, could be chosen for a culturally relevant discussion of nuclear disasters. Alternatively, European examples may be found for discussion of the use of nuclear energy as a major provider in France or its discontinuation in Germany.

## EXERCISE

Consider the arguments presented in the two contrasting articles presented in Boxes 8 and 9. Use the guide questions at the end of the exercise to formulate ideas for presentation/debate/discussion with your school/group.



### Box 8

## Making the safe, sustainable investment

It is clear that alternatives to fossil fuels must be developed on a large scale. However, nuclear power is neither renewable nor clean and therefore not an option. Even if one were to disregard the waste problems, safety risks and dismal economics, nuclear power is both too slow and too limited a solution to global warming and energy insecurity. Given the urgent need to begin reducing greenhouse gas emissions, the long lead times required for the design, permitting and construction of nuclear reactors render nuclear power an ineffective option for addressing global warming.

In fact, improving energy efficiency is the most cost-effective and sustainable way to concurrently reduce energy demand and curb greenhouse gas emissions. Wind power already is less expensive than nuclear power. And while photovoltaic power is currently more expensive than nuclear energy, the price of electricity produced by the sun, as with wind and other forms of renewable energy, is falling quickly.

Conversely, the cost of nuclear power is rising. When the very serious risk of accidents, proliferation, terrorism and nuclear war are considered, it is clear that investment in nuclear power as a climate change solution is not only misguided, but also highly dangerous. As we look for solutions to the dual threats of global warming and energy insecurity, we should focus our efforts on improving energy conservation and efficiency and expanding the use of safe, clean renewable forms of energy to build a new energy future for the nation.

PHYSICIANS FOR SOCIAL RESPONSIBILITY

[www.psr.org/resources/nuclear-power-factsheet.html](http://www.psr.org/resources/nuclear-power-factsheet.html)

(Accessed 5 January 2017)

ESD question	Both points of view consider the economic argument. What other perspectives should be considered in evaluating their credibility?
ESD question	What are the benefits and hazards of nuclear science in areas other than energy production?
ESD question	What compromises would need to be made if countries abandoned nuclear energy?
ESD question	Are the arguments for/against nuclear energy the same for established and emerging economies?
ESD question	Nuclear CO <sub>2</sub> emissions are 5–7 g per kW/h compared with coal's 900 g per kW/h. Is nuclear energy a sustainable alternative to fossil-fuel economies and long-term energy security?

## Box 9

## A case for nuclear energy

India's Civil Nuclear Power Programme uses thorium and uranium to produce sustainable renewable energy. The Union Budget of India for 2016–17 allocates Rs. 3,000 crore per annum for the next 15–20 years. Finance Minister Arun Jaitley remarked that this investment is required to diversify sources of energy for the future. India currently has 21 nuclear power reactors in seven locations. Together, they produce 5,780 MW of electric power. Two months ago, the Nuclear Power Corporation of India (NPCIL) signed a contract with Électricité de France (EDF) to set up six more nuclear plants around the country. According to the International Agency of Atomic Energy (IAEA), in 2015 India generated a total of 34,644 GW.h of electricity through nuclear power. This amounted to just 3.53 per cent of India's total energy production. India should increase its reliance on nuclear energy.

A recent report released by Greenpeace India indicates that an average Indian was exposed to more lung-damaging particulate pollution than a Chinese in 2015. In both countries there has been an increased use of fossil fuels over the last decade.

Using control technologies, China was able to reduce its particulate pollution by 17 per cent. By contrast, pollution through particles like dirt, soot and smog increased by 13 per cent in India during the same period. According to the World Health Organisation, pollution in major cities in India like New Delhi has worsened over the past decade. India only has 39 air quality monitoring stations whereas China has 1,500. Nuclear power produces no air pollution and no greenhouse gases. It seems time for India to regard nuclear power as a serious alternative source of energy, along with wind, solar and hydropower. Recently, Japan's Prime Minister Shinzo Abe said Japan 'cannot do without' nuclear energy. Nuclear energy is clean; the price is not fluctuating; and nuclear is far and away the cleanest form of energy in current use. The International Energy Agency (IEA) predicted in 2014 that projects relating to nuclear energy are going to increase by 60 per cent through to 2040. Nuclear energy is under-favoured because of outdated safety and waste disposal concerns and because it has been capital-intensive. Super-safe small modular reactors that reprocess most of the waste should overcome these concerns. It has been estimated that during 2016–17, 41,500 GW.h of energy will be produced through nuclear energy, which is an increase from last year.

According to IEA, India currently has more than 250 million people without electricity supply. Most are in rural households and live below the poverty line. The aim of the government as revealed by Mr Jitendra Singh of India's Department of Atomic Energy is to triple the current nuclear power generation. In order to meet national and especially rural electricity demands, the Modi government should promote nuclear energy.

ARMIN ROSENCRANZ AND PITAMBER YADAV

*The Statesman*, 17 March 2016

[www.thestatesman.com/opinion/a-case-for-nuclear-energy-130386.html](http://www.thestatesman.com/opinion/a-case-for-nuclear-energy-130386.html)



## 4.4

**Topic: Ecosystem dynamics, plant and animal interactions****APPROACH:** Issue-centric STSE using storyline and problem-based learning

In contrast to the previous examples in section 4, this example shows the potential of the STSE model for embedding ESD in textbooks using an issue-centric entry point while still making strong associations with curriculum requirements.

**STEP 1 Issue identification and association with curriculum requirements****Issue: Declining bee populations**

Textbook authors should note that this issue relates to the wider curriculum requirements of ecosystem dynamics, food security and agricultural practice. It engages well with learning outcomes taken from Canada's Grade 7 science curriculum for British Columbia (Box 10), where the ecosystem, biodiversity and food web concepts feature strongly. (These are also common ideas in science curricula worldwide.)

**STEP 2 Connecting issues with learning outcomes**

When introduced in textbooks, this issue can be connected/expanded to ESD learning outcomes, such as those noted in the lower half of Box 11 (GM crop monoculture and use of pesticides and insecticides), while maintaining strong links with curriculum specifications. The textbook should also seek to support such associations with science-based research outcomes, which may be evaluated by the learners and which increase the validity of the points of view forwarded. For example: 'Researchers have noted that global warming also impacts on bumblebee habitats and results in bee population decline.' Figure 8 shows how the generic model introduced in section 3.2.1 adapts to the declining bee population scenario in this example.

The declining bee population and loss of colonies is a global ecological and economic concern. It is recognized as an indicator of ecosystem disruption that is potentially attributable to a number of unsustainable land management and agricultural practices.

**Box 10****Learning outcomes for the elementary science curriculum, Ministry of Education, Province of British Columbia, Canada****Life science: habitats and communities (2005)**

Learners should be able to:

1. Analyze the roles of organisms as part of interconnected food webs, populations, communities and ecosystems.
2. Assess survival needs and interactions between organisms and environment.
3. Assess the requirements for sustaining healthy local ecosystems.

**Suggested ESD learning outcomes:**

Learners should be able to:

1. Understand the dependence of food security on natural systems.
2. Appreciate the impacts that industrialized agricultural practices have on original land and methods of agriculture.
3. Evaluate human impacts on local ecosystems and expand this to a global perception.



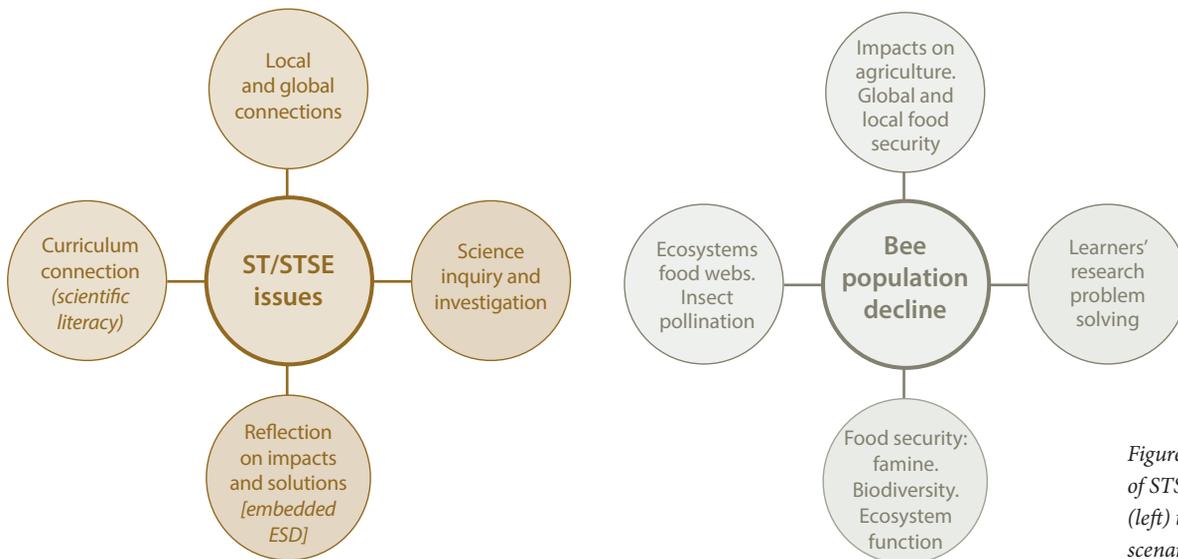
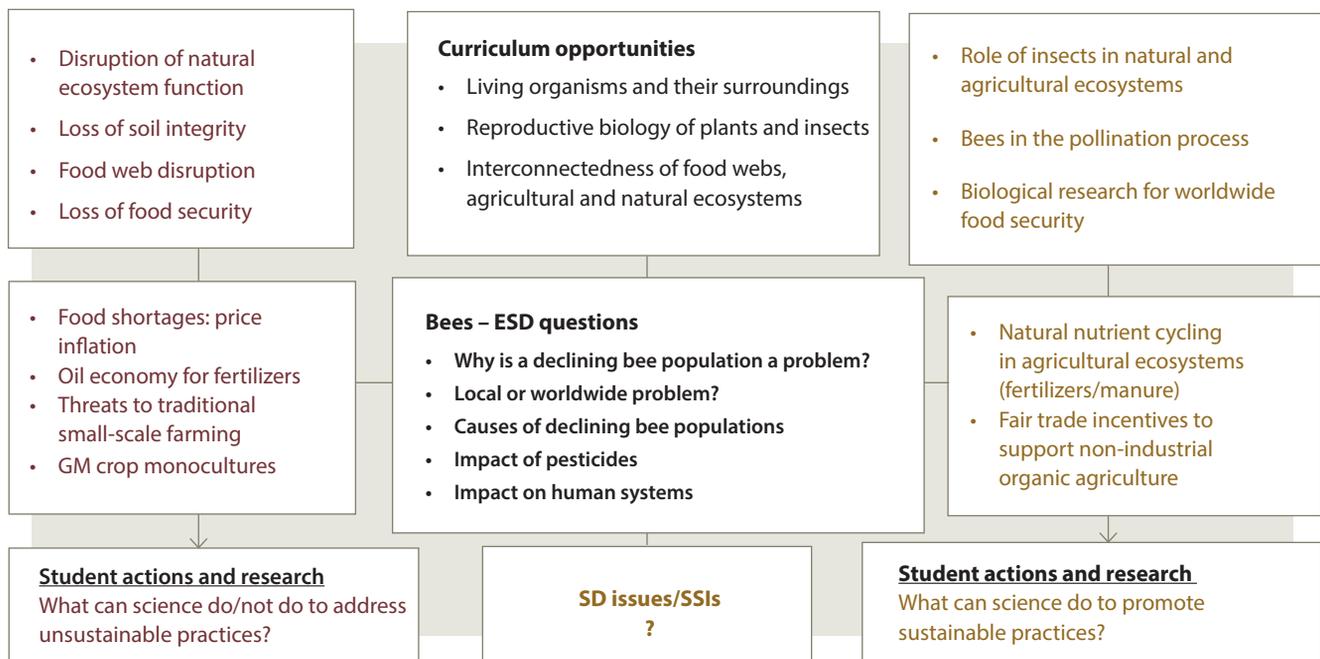


Figure 8: Adaptation of STSE generic model (left) to fit current story scenario (right)

**STEP 3 Identifying curriculum opportunities for embedding ESD**

Most curricula make clear that scientific inquiry and investigation skills are essential 21st century competencies for learners. The ability to evaluate SD issues in an informed manner should be similarly considered. The investigative skills associated with the exploration of sustainable development issues integrate well with problem-based learning approaches. Learners recognize the problem, plan

for problem solving, process their plans and arrive at conclusions or solutions. While Figure 8 clarifies the relationships between ESD and the other domains of the model, it does not give clear guidance on how curriculum opportunities may be identified and engaged with. Figure 9 employs the same mapping tool that was used in previous examples to address these shortcomings. It also makes clear how this technique creates a central focal point for wrapping science topics around related and relevant issues.



**Advisory note for authors**

The 'story' in this example is close and relevant to the everyday life experiences of Canadian students living in rural areas. The original storyline was developed in the context of British Columbia to encourage learners to understand the local bee population problem as it relates to their everyday lives. This context may need to be adapted to relate to the lives of learners who reside in urban or other different geographical environments.

Figure 9: Framework to identify curriculum ESD opportunities and issues

**Textbook authors might wish to consider this key question**

What are the origins of the issues identified and what embedded material will enable learners to identify with these and address them in their own research? Here, the powerful role of the textbook lies in its ability to align the story and learners' inquiry skills with the science curriculum being followed.

## EXAMPLE 4

### Elementary science (biology – habitats and communities)

#### Advisory note for authors

Sequence for topic structure using STSE scenario approach with problem-based learning (Figure 7).

1. Introduce science concepts. *Understanding of the SSIs raised by the story is informed by the curriculum shown in Box 11, in this case, concepts such ecosystem function, sexual reproduction of flowering plants, food webs and insect pollination. The curriculum-based science can then be translated into research-informed identification of SSIs and wider SD issues. This gives learners an academic framework with which to contextualize the story/scenario.*
2. Present the STSE story/problem context.
3. Instigate investigation. *Inclusion of students' inquiry activities in the textbook topic is important to enable learners to develop critical thinking and problem-solving skills. This may be undertaken as a series of questions designed to promote investigative skills as preparation for debate/discussion.*

**Research activity:** Read the story in Box 11 and think about the issues raised.

Scenario appropriate to elementary/primary learning stages.

#### Box 11

#### Bee populations decline



Storyline: The broad geography and climate of British Columbia, Canada, means agricultural activities are abundant. There are many farms around this region and British Columbians are heavily involved in agriculture, visiting farms to harvest produce (for example, cherries), gardening, etc. There are also many private and commercial bee keepers, who keep hives in their gardens.

This story begins with children playing around their garden, which contains several bee hives. The children love to eat honey from their hives and are curious about how their parents harvest it. They hear their parents saying that the amount of honey they harvest is declining. The children ask why and the parents tell them there are fewer bees in the area than there have been in the past. The children begin to wonder why the bees are in decline and so begin to research the bee population.

They ask: 'Why is this happening?'

*Equally this approach may be scaled up to relate to an older cohort using the same techniques. Box 12 shows an example of a related but more advanced article considering the same subject. A series of curriculum-focused science and ESD questions follow to promote critical thinking skills and consideration of wider SD issues informed by the curriculum-led science being studied.*

**Box 12****Pesticides linked to bee decline for first time in countrywide field study**

*Alison Benjamin, The Guardian, Thursday 20 August 2015*

Landscape-wide research by a UK government agency on oilseed rape fields in England and Wales shows links between neonicotinoids (pesticides) and honeybee colony losses. A new study provides the first evidence of a link between neonicotinoid pesticides and escalating honeybee colony losses on a landscape level. The study found the increased use of a pesticide, which is linked to causing serious harm in bees worldwide, as a seed treatment on oilseed rape in England and Wales over an 11-year period correlated with higher bee mortality during that time.

The total area of land planted with oilseed rape in England and Wales more than doubled from 293,378 hectares (724,952 acres) to 602,270 hectares over that time and the number of seeds treated with the imidacloprid pesticide increased from less than 1 per cent of the area planted in 2000 to more than 75 per cent of the area planted with oilseed rape by 2010.

The honeybee is the most important commercial pollinator, globally responsible for pollinating at least 90 per cent of commercial crops. They are the most frequent flower visitor to oilseed rape. The report's authors said: 'As long as acute toxins remain the basis of agricultural pest control practices, society will be forced to weigh the benefits of pesticides against their collateral damage. Nowhere is this tension more evident than in the system with the world's most widely used insecticide, the world's most widely used managed pollinator and Europe's most widely grown mass flowering crop.'

The UK government has always maintained that neonicotinoid pesticides do not threaten bees. It has laid the blame for high honeybee losses on the parasitic varroa mite, which spreads viruses, and wet summers that prevent bees from foraging.

A European-wide two-year ban on a number of pesticides linked to bee deaths came into force in December 2013. Last month, the UK government temporarily overturned the ban on two pesticides on about 5 per cent of England's oilseed rape crop. The Department for Environment, Food and Rural Affairs (Defra) said the emergency authorisation did not apply to imidacloprid. It added that the use of this particular pesticide had fallen dramatically in the UK, down from 43,900 kilos in 2005 to just 7,250 kilos in 2013.

A Defra spokesperson said: 'This paper provides evidence that neonicotinoid seed treatments can reduce the need for more pesticide use on crops. Large-scale field studies are needed to fully understand their effects on the environment. The government makes decisions on pesticides based on the best available scientific evidence.'

Paul de Zylva, senior nature campaigner at Friends of the Earth, said the Fera study added to the growing evidence showing the harm neonicotinoid pesticides do to pollinators. 'The pesticide industry can't continue to maintain that there is no effect of their products on honeybees and wild bumblebees and solitary bees,' he said.

*Scenario appropriate to A Level/secondary learning stages.*

**Activity for older learners:** Prepare answers to these questions for discussion with your class groups and teachers.

<b>ESD question</b>	Would all countries be affected equally by declining bee populations?
<b>Science question</b>	How would the use of GM crops be affected by declining bee populations? Give reasons for your answer.
<b>Science question</b>	What biological factors other than pesticides might be responsible for bee population decline?
<b>ESD question</b>	If the use of pesticides was discontinued or reduced, how do you think this would affect world agriculture and global food security?
<b>ESD/science question</b>	What biological alternatives to the use of pesticides might be able to be used to protect agricultural systems from attack from insect populations?
<b>ESD question</b>	Use the internet to research the health of bee populations in China and Japan to compare with those of Canada and UK.

## 5.0

## Final considerations

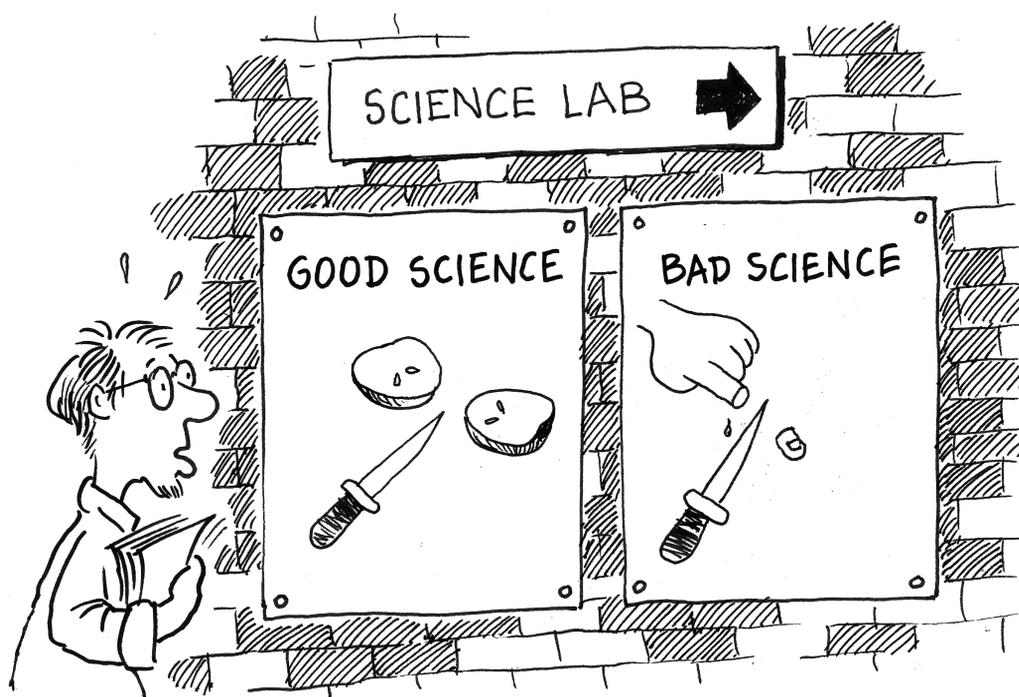
Researchers have found that many learners develop stereotypical views of science as boring, Eurocentric and male dominated (Johnston, 2013; Özel, 2012; Archer et al, 2010; Tucker-Raymond et al, 2007; Zhai, Jocz and Tan, 2014).

*Science needs to be more inclusive of marginalized and minority groups*

In this chapter we have noted that, in many cases, school science is disconnected from learners' everyday lives and fails to portray a world with which they have a personal affinity. Portraits of scientists in the media, such as children's books and magazines, also present certain stereotypes. In the interest of putting our own house in order, it is important to note that there still appears to be a male bias among those learners who define science as the natural home for their studies, personal development and career aspirations. Additionally, in many parts of the world, poverty exerts pressures that exclude many minority groups from this important area of human endeavour.

The guiding principles, models and strategies considered in this chapter all focus on issues as they are defined under the overarching term 'sustainable development' (United Nations 2015). Some issues can be recognized more easily than others in the embedding process and some are more easily addressed than others. The mapping tools used in the examples provide opportunities to develop extended associations and relevance in the areas of citizenship, social justice and gender/social equality. It would take many examples to ensure full awareness of all the issues valid under this umbrella term and we hope that those included here will provide useful templates for textbook authors to follow.

A legitimate criticism of any example might be that it is limited by addressing a specific suite of SD issues to the exclusion of others. In the case of the science examples presented in this chapter, there is inevitably a focus on physical impacts. It should be acknowledged, however, that where these impacts occur, there is a range of associated economic, sociological and political pressures that have their origins in these impacts. We acknowledge the difficulties and challenges that science textbook authors might face in embedding ESD and pay due respect in advance to their efforts. The authors of this chapter in no way claim to have all the answers. However, on the basis of our joint experience, we hope the discussion and examples in this chapter highlight issues too often neglected. Embedding ESD in (science) textbooks has been the central focus of the chapter. However, after engaging with this closely, we hope that it becomes clear that the next logical step is to develop a fully integrated curriculum embedding ESD as a major step towards supporting future generations achieve more sustainable practices and viewpoints.



## 6.0

## References

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‘Articulating geographical facts along core concepts of geography – such as place, space, scale or environment – helps us to look at SD issues with a ‘geographer’s eye’ and contributes to the holistic approach inherent in SD and global citizenship’



## GEOGRAPHY

	<b>Introduction</b>	105
<b>1.0</b>	<b>What has geography to do with sustainable development, global citizenship and peace – and what does this mean for education?</b>	106
1.1	Geographies and their contribution to sustainable development	106
1.1.1	Combining physical and human geographies for SD	106
1.1.2	Describing, understanding and shaping the world for SD	106
1.1.3	Organizing spatial knowledge along core concepts	108
1.2	Implications for geography education and its contribution to ESD	110
1.2.1	What type of geographical content favours ESD?	110
1.2.2	Which features of geographical pedagogies contribute to ESD?	111
1.2.3	Reflecting on geographical knowledge for ESD	114
1.2.4	Conclusion: the importance of achieving the right blend of content and pedagogy in geographical education for ESD	114
<b>2.0</b>	<b>Getting tangible: how to embed ESD in geography textbooks</b>	115
2.1	How to select geographical content for ESD – content criteria	116
2.1.1	Example of selecting content for the topic of water – chapter level	118
2.1.2	Example of selecting content for the topic of water – task level	120
2.2	How to create tasks in geography that embed ESD – pedagogical principles	122
2.2.1	General pedagogical principles	122
2.2.2	ESD-related pedagogical principles	123
2.2.3	Example of creating geographical tasks along ESD principles for the topic of water	128
2.2.4	Examples of tools that work along ESD principles within geographical education	130
<b>3.0</b>	<b>Examples of embedding in geography textbooks</b>	133
3.1	Embedding example: daily geographies for young children	134
3.2	Turning existing ESD-compatible examples into ESD examples	138
<b>4.0</b>	<b>References</b>	150

# Geography is used for wars but has a huge potential to foster peace



*‘When you meet people at a party and tell them you’re a geographer, they tend to ask you about distant places, capital cities and longest rivers. In my experience, they rarely ask you about globalisation, sustainability, inequality or the other big issues about which geographers actually have a lot to say.’*

*(Jackson, 2006, p. 199)*

WHILE GEOGRAPHY CAN be thought of in terms of knowing the names of capital cities, it can also be seen as a way of (re)organizing the world. It can draw straight and arbitrary borders but can also make sense of complex systems at a glance. It can reinforce existing power relationships or question them. Geography is used for wars but has a huge potential to foster peace. It can help us understand local issues as well as highlight their links to global phenomena. Geography can be looked at as a static set of encyclopaedic knowledge or as a dynamic way of seeing, thinking and contributing to the world. The variety in understandings of geography is mirrored in the variety of approaches to geographical education, influenced by a number of diverse pedagogical approaches. This chapter addresses this variety and offers ways in which geographical education can contribute to educating for sustainable development, peace and global citizenship. It focuses on related implications for textbooks and discusses ways of embedding ESD, used as an umbrella term.

The first section outlines ways in which geography can contribute to sustainable development (SD), peace and global citizenship and their related educations. The second section examines this link at

a more concrete level and presents tools for authors wishing to embed ESD into geography textbooks. Two checklists (presented as ‘spider-webs’) have been developed to offer guidance when shaping geographical content for ESD and for elaborating geographical tasks in coherence with ESD. This tandem relationship between content<sup>1</sup> and pedagogy is a central issue within the chapter and will be looked at again in the third section, which focuses on new, potential and existing embedding examples.

The understanding of SD, ESD and embedding aligns with the one presented in the Introductory chapter:

- The option to work according to a weak (anthropocentric) or strong (biocentric) conception of SD is left open because an integrative conception of SD has been chosen for this work (see p. 16).
- When embedding is concerned, we follow the idea of a strong ESD structure (see p. 17).
- ESD is seen as a ‘built-in approach’ according to Sterling’s definition (2004, in Lotz-Sisitka et al, 2015, p. 73), tending to a ‘whole system re-design’ (see p. 18).

<sup>1</sup> We understand content as a combination of factual knowledge and a way of organizing it along concepts related to the discipline (see sections 1.1.3 and 1.2.1). Other aspects of knowledge, such as procedural knowledge (for example, reading a map), are included in the use of the word ‘knowledge’ and are addressed, for example, in section 1.2.2).

**1.0**

# What has geography to do with sustainable development, global citizenship and peace – and what does this mean for education?

According to the classical Greek etymology,<sup>2</sup> geography may be understood as the intellectual effort of ‘writing’ the ‘earth’. Reinfried and Hertig (2011, p. 5) acknowledge that ‘basically, the object of geography is the earth or earth surface’. However, they underline that beyond this general definition, understandings of geography can vary. This is stressed by Morgan (2013, p. 274) when stipulating that ‘rather than a singular Geography, there exist multiple geographies’ as the discipline has moved ‘through a sequence of paradigms, from a focus on regional geography through a range of quantitative, humanist, structuralist approaches, lately heavily influenced by post-modern cultural thinking’ (Rawding, 2013, p. 288). The aim of this section is not to close a debate that has endured for centuries, but to point out general trends and possible articulations to illustrate how different geographies can be of interest to SD. The second part of this section discusses the implications this has for a geographical education contributing to ESD. The reflections are articulated around elements from the 2016 *International Charter on Geographical Education*, a document that has a broad acceptance worldwide.

**1.1**

## Geographies and their contribution to sustainable development

We will look at three ways in which geography has the potential to contribute to SD:

- In combining physical and human geography.
- In using the complementarity of diverse approaches to spatial variability.
- In considering ‘core concepts’ of geography for organizing geographical facts.

**1.1.1**

### Combining physical and human geographies for SD

A first distinction within geography is the one between physical and human geography, with both looking at the spatial dimension of studied subjects. Different areas of the world may set their focus on one or the other. However, there is now a broad consensus that contemporary geography should aim to investigate the interrelation between human and physical geography, as made clear in the 2016 *International Charter on Geographical Education*: ‘Geography is the study of Earth and its natural and human environments, [it] enables the study of human activities and their interrelationships and interactions with environments from local to global scales’ (IGU-CGE, 2016, p. 4).

This ‘bridging’ theoretical position equips geography to look at production and development from the perspective of ecological and social sustainability, and not merely from an economist’s view of conservation of resources for economic production. This gives it the potential to contribute to a strong vision of SD. Studying the interrelations between ecosystems and societies, which are sometimes considered as being a part of the ecosystems, also helps to see our planet and its components as a system with imbricated subsystems. In other words, ‘Earth is seen as a human-environment-system from a spatial perspective’ (Rempfler and Uphues, 2012, p. 9). This encourages us to acknowledge the intricacies of our relationships with societies across the world, and our dependence on the environment. It shows the necessity of stewardship and collaboration across cultures to solve global challenges, and encourages us to reflect on the consequences of our choices and actions on our living systems, which, in turn, influence us. This ‘bridging’ position also allows us to look closely at natural ecosystems as models of sustainability and to see potential parallels in the way our societies work.

**1.1.2**

### Describing, understanding and shaping the world for SD

The second part of the definition of geography given in the 2016 *International Charter on Geographical Education* states that: ‘While geography often bridges natural and social sciences, it is pre-eminently the discipline that deals with spatial variability, i.e. that phenomena, events and processes vary within and

*Earth is seen as a human-environment-system from a spatial perspective. Both physical and human geography are needed to tackle/address this system*

<sup>2</sup>Geography:

γεωγραφία (γῆ ‘Earth’ + γραφία ‘To write’).

between places and therefore should be regarded as an essential part of the education of all citizens in all Societies' (IGU-CGE 2016, p. 4).

Geographical discourse around spatial variability can be articulated in three ways of thinking about the world. They can be considered 'at the same time successional and complementary in their mindset' (Rétaillé, 2000, in Reinfried and Hertig, 2011 p. 8). These three ways can be summarized as follows (Rétaillé, 2000; Varcher, 2008; Hertig, 2011; all in Reinfried and Hertig, 2011):

- One perspective sees the world as a planet whose parts are localized, named and characterized, with topographical maps as a starting point (idiographic approach). The focus is on describing the specificities of these parts in relation to others. This perspective can be related to approaches prevailing in the 1950s (see Hartshorne, 1959) and they still have an influence today within regional geography. 'Each place being unique in its characteristics, the outcomes of similar environmental and socioeconomic processes may vary between places, and similar problems may require different strategies in different places' (Maud, 2015, p. 19). For example, a densely populated city in a semi-arid climatic zone does not organize energy consumption in the same way as a city with a low population density in a cold area. Therefore, they will look for adapted solutions when aiming to reduce the emission of greenhouse gases. This perspective contributes to understanding local issues in depth and determining how they may relate to issues elsewhere, therefore helping to shape locally relevant alternatives for SD.
- Another perspective sees the world as an entity that is measured and organized (nomothetic approach). The aim is to identify localization rules and spatial organization patterns to highlight regularities and invariants within space, be it patterns of polarization (for example, concentration of services in cities) or diffusion (for example, population movements). This can relate to the quantitative revolution of geography as initiated by the work of Schaefer (1953). Quantitative data, modelling and thematic maps are core tools within this approach, having gained power with the improvements in remote sensing and geographical information systems. As 'spatial distributions have environmental, economic, social and political [causes and] consequences' (Maud, 2015, p. 19), it is of interest for SD to look at them. For example, in Australia 'the spatial concentration of the population into just five cities has environmental consequences, because of the concentration of pollution or the construction of water storages, and political consequences, because of the influence of urban voters on governments' (ibid). This is of relevance to SD because it helps in identifying unsustainable

schemes and their reproduction at a large scale, prioritizing areas of intervention, identifying leverages for action and analyzing possible effects of change.

- A third perspective sees a world whose meaning and finality is to be explored. It looks at 'actors and their intentions and thereby draws the cultural, symbolic and political dimensions of space and of spatial facts to our attention' (Hertig, 2011; Varcher 2008, all in Reinfried and Hertig, 2011, p. 8). This perspective, gathering humanistic and cultural approaches to geography, is articulated along three closely linked aspects:
  - The study of place allows us to identify dynamics of power and social relations present in society. Cities, for example, would be studied in terms of social justice and environmental issues (see Harvey, 1973). The fact that some parts of a city lack basic infrastructure, inducing pollution and illness through the absence of waste-treatment plants, shows unequal access to services and resources among the city's population. Therefore, looking at ways in which a place is organized can help in identifying unsustainable (or sustainable) practices and can address issues of social justice.
  - People give spaces meanings based on their subjective, social, economic, cultural, political and ethical experiences (Tuan, 1974 and 1975; Massey, 1994 and 1994b; Frémont, 2005; Hubbard, 2005). A forest has a different meaning for a community living in it and seeing its spiritual dimension than for a corporation wanting to exploit wood for economic purposes. Both actors will interact with the forest in different ways. Understanding the meaning given to a place helps to identify more or less sustainable forms of human-nature or human-human interactions and gives insight into the perspectives of people affected by or carrying out unsustainable practices.
  - Similarly, actors shape a place according to their needs, representations, values and worldviews, as well as their power in society (Cosgrove and Daniel, 1988; Dalby, 1991; Ó Tuathail, 1996). Therefore, they have the power to reinforce narratives, bias, stereotypes and power relationships – or to challenge them in presenting alternative ways of shaping places (Dalby, 1991; Ó Tuathail, 1996). Planning to build a supermarket in an industrial area inaccessible by public transport shows different logic and values to planning a network of small shops in a densely populated area. It also has a different impact on the environment and society. In other words, the representation of what is 'adequate' planning differs and is related to the societal and individual values given to space

*To describe specificities of localized places, to identify localization rules and spatial organization patterns and to look at actors and their intentions when shaping space are three facets of geography that contribute to a better understanding of SD-related issues*

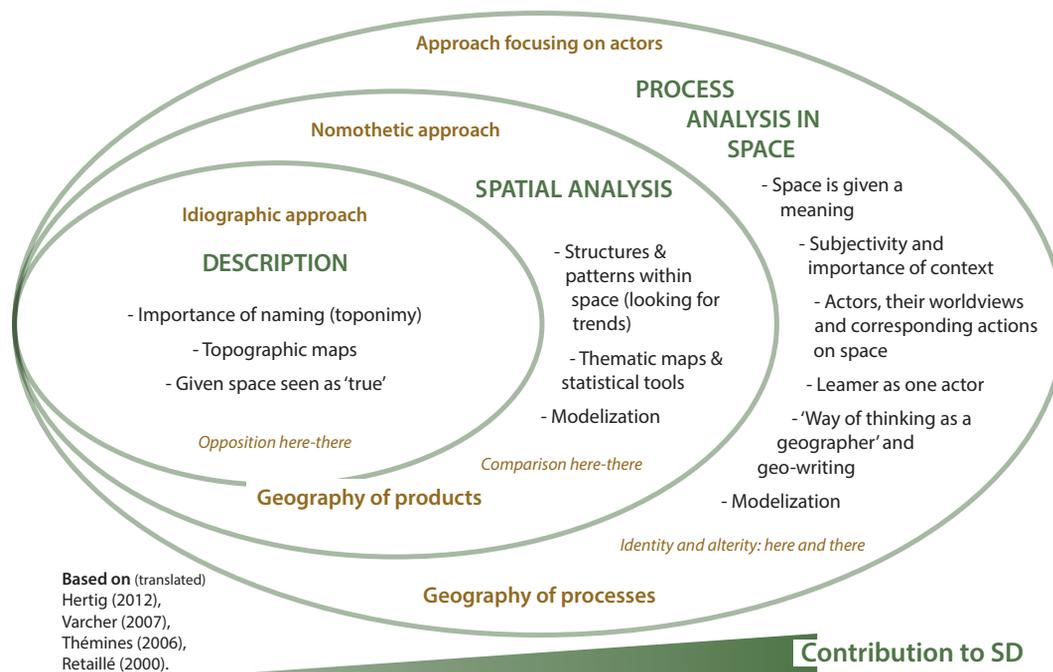


Figure 1:  
Complementary  
approaches to spatial  
variability – moving from  
a descriptive geography to  
a geography of processes

and its components, and to power relationships between actors within this given space. The consideration of values and power within spatial action makes a core contribution to SD because it deals with issues of equity, justice and peace.

In all these three aspects, actors are not considered neutral and can be seen as individuals or as collectives, such as enterprises, local communities and organizations from civil society, governments or supra-national government bodies. Audigier (2011) describes this continuum between the individual and the collective as social scales. This is crucial to SD because it looks for a balance between individual needs and common interests and aims to set sustainability-driven priorities among diverging interests. It is also of relevance to citizenship in general, as mentioned in the 2016 charter, as well as for global citizenship, social justice and peace.

*A geography that follows the vision of SD has the power to reshape places and spaces and create alternative worlds*

In brief, focusing on actors and related spatial actions while looking at place and space as indicators of social organization and worldviews can help to identify (un)sustainable practices and underlying values that may lead to inequities and resource depletion. It therefore questions the roots of (un)sustainable practices and beliefs and addresses conflicting interests while having the potential to help identify blocking or supportive mechanisms for SD. In the same logic, geography also has the power to suggest alternative ways of organizing place and space in coherence with SD. This implies that geography may have an evident political connotation and is strongly determined by socio-economical, cultural, ideological and even personal contexts (see also section 1.2.3). On the other hand, geography has the power to influence these contexts. In this sense, a geography that follows the vision of SD has the power to reshape places and spaces and create alternative worlds.

Figure 1 illustrates these three ways of seeing the world. It also shows that the relevance of geography to SD is compromised if the descriptive level is the only level considered because taking patterns and processes into account is of crucial importance for a better understanding of SD-related issues.

### 1.1.3

## Organizing spatial knowledge along core concepts

Underlying concepts common to all 'geographies' can be identified in the definition of geography given by the 2016 *International Charter on Geographical Education: place, space, scale and environment*.<sup>3</sup> Environment is understood as 'our living and non-living surroundings' (Geographical Association, 2012, p. 4) and these are addressed explicitly. They are considered to be 'core concepts' of the discipline (Matthews and Herbert, 2008, in Morgan, 2013) and seen as 'important ideas' or 'integrative concepts' that help to organize geographical knowledge (Reinfried and Hertig, 2011; Geographical Association, 2012; Brooks, 2013). Other candidates include location (Geographical Association, 2012) or 'time' (Taylor, 2008, in Brooks, 2013).

*PLACE is a part of the earth's surface, or a location, given a unique character by the human and natural phenomena present in it (Reinfried and Hertig, 2011). A place is 'given meaning by the people who live in and use it' (Lambert, 2011, p. 262).*

*SPACE is a 'three-dimensional uninterrupted surface of the earth on which everything is located and*

<sup>3</sup> Interaction or interrelations are sometimes used more or less as synonyms for 'environment'.

across which people, goods and information move' (Australian curriculum).<sup>4</sup>

*SCALE is a way of looking at 'geographical phenomena and problems at different spatial levels, such as local scale, and global scale (spatial scale)' (Australian curriculum).*

*ENVIRONMENT in the wide sense 'is the result of the interaction of physical and human features creating the conditions and resources on which life on earth depends' (Lambert, 2011, p. 162).*

Talking about these core concepts, Lambert (2004) distinguishes between the 'vocabulary' of geography, seen as geographical facts, which are mobilized by good 'grammar', seen as geographical concepts, in order to make sense of the world. He therefore insists on the power of thinking geographically, which is an approach gaining in acceptance (see also 1.2.2). Jackson (2006) goes a step further in affirming that it is crucial to see these concepts in relation to one another. For example, linking place with space helps us recognize the interaction between local specificities and broader dynamics. And looking at an issue at different scales while identifying their connection to one another helps us change perspective and identify implications at certain scales not visible at others. The interrelated nature of these core concepts contributes to the holistic approach promoted by SD and global citizenship. Both are strongly rooted in local processes while also considering 'the bigger picture'. Through the study of geography, therefore, we can better understand the (un)sustainability of our individual and collective actions and are able to interpret the spatial relevance of social, environmental and political changes at local and global scales in our daily lives.

The idea of process mentioned in the definition also implies that time plays a role. Thus, time is not only an historical concept but also a geographical one (Taylor, 2008, in Brooks, 2013). It enables us to look at the evolution of a landscape and the related values of a society. For example, large roads entering cities illustrate the central status of cars in the western world of the 1960s. This way of structuring space is still visible at present, although urban planning now tends to set a clearer focus on public transport. Looking at evolutions in space over time echoes the fact that SD is about intergenerational equity.

These elements are reflected in the summary below. They influence the understanding of how geographical education contributes to ESD, as discussed in the next section.

### SUMMARY

A geography contributing to SD is one that:

- Combines human and physical geography by looking at the interaction and interdependence between societies and their natural environment at different spatial scales, thus having a holistic approach inherent to SD.
- Combines the description of places, the analysis of patterns in space and the study of spatial processes shaped by actors. It does this in such a way as to 'read' the world to gain a better understanding of sustainability issues and to 'write' the world in proposing alternative ways of organizing space for SD.
- Refers to core elements common to all geographies that underline specific contributions the discipline can make to SD (for example, looking at various spatial scales).

<sup>4</sup><http://www.australiancurriculum.edu.au/seniorsecondary/humanities-and-social-sciences/geography/glossary>

*Articulating geographical facts along core concepts of geography, such as place, space, scale or environment, helps us to look at SD issues with a 'geographer's eye' and contributes to the holistic approach inherent in SD and global citizenship*

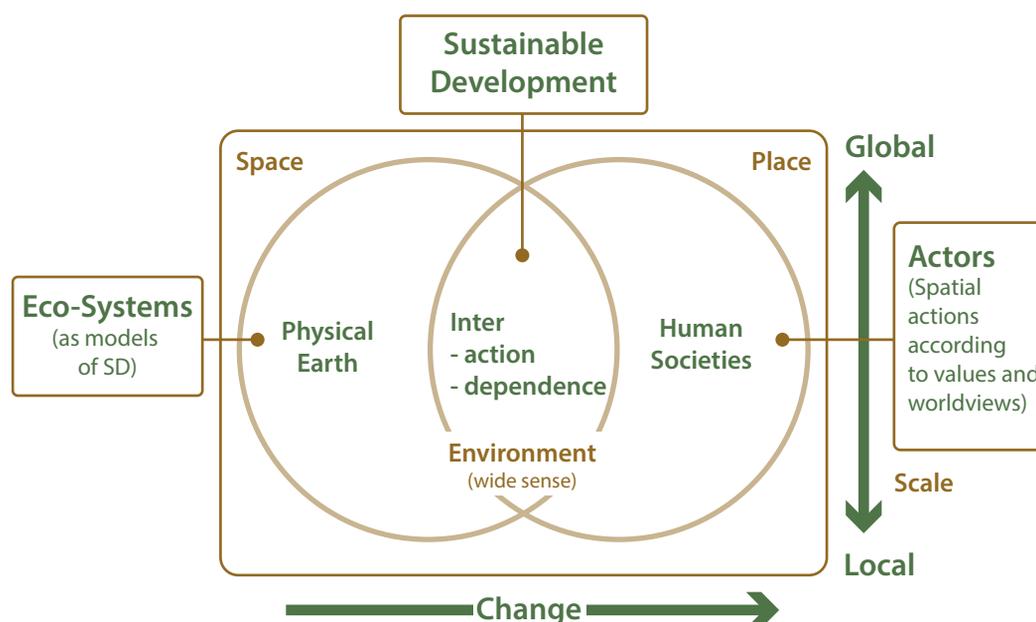


Figure 2:  
Features of geography  
contributing to SD

## 1.2

## Implications for geography education and its contribution to ESD

*Geographical education has the potential to make a core contribution to ESD, depending upon which type of geography and which pedagogy is implemented. But this potential is under-exploited*

*Whether it is through appreciating the beauty of Earth, the immense power of Earth-shaping forces or the often ingenious ways in which people create their living in different environments and circumstances, studying geography helps people to understand and appreciate how places and landscapes are formed, how people and environments interact, the consequences that arise from our everyday spatial decisions, and Earth's diverse and interconnected mosaic of cultures and societies. Geography therefore is a vital subject and resource for 21st century citizens living in a tightly interconnected world. It enables us to face questions of what it means to live sustainably in this world. Geographically educated individuals understand human relationships and their responsibilities to both the natural environment and to others. Geographical education helps people to learn how to exist harmoniously with all living species.*

*International Charter on Geographical Education, 2016, p. 5*

This description of geography's contribution to education introduces the idea that geographical education has an explicit link to SD and an implicit link to global citizenship and peace. The evident contribution of geography to SD discussed in the

previous section has created a close relationship between geography education and ESD. Several national school systems and curricula already promote the integration of SD (as content) or ESD (as a pedagogical concept) into school geography, and many ESD experts are geographers. Smith (2013, p. 257) says: 'It is the geography subject area within the school curriculum that is often given major responsibility for teaching and learning about sustainable development.' In other words, geographical education has the potential to make a core contribution to ESD, depending upon which type of geography and which pedagogy are implemented.

This potential, however, is under-exploited. The developments in geographical education over the past six decades have introduced a theoretical and pedagogical focus on issues such as SD, ecological and social relationships and responsible citizenship (Soltman, 2006). However, it is taking time for these changes to be broadly reflected in school textbooks (Sunny, 2006). Some examples that harness this potential have emerged (see last section), but often the type of geography that is promoted still focuses on a descriptive 'capes and bays' approach using methods that are not favourable to ESD.

To exploit that potential more systematically, the following section discusses how geographical education can contribute to ESD by looking at two important aspects of textbooks: the type of geographical content that is worked on in the document, and the kind of pedagogy applied.

## 1.2.1

### What type of geographical content favours ESD?

Based on the conclusions of section 1, geographical content favouring ESD focuses on the interrelation of natural and human systems, looks at the different facets of spatial variability (including the role of actors) and articulates spatial knowledge around key geographical concepts.

#### Example for the topic of natural hazards

An examination of the topic 'natural hazards' (seen as natural phenomena affecting human societies) shows how a textbook writer can contribute to ESD through content. A key element in addressing the topic is the understanding of the natural phenomenon or risk. For example, how volcanism works, why it is mostly located at the limit of tectonic plates, the different types of volcanism and so on. Another fundamental aspect of the topic is the consideration of the vulnerability of the societies confronting the risk. By studying societies that have settled around volcanoes and coped with the related risks, we are able to identify the different factors influencing the degree of vulnerability. This would be a classical way of tackling the topic.

Looking more precisely at the interrelation of societies and their natural environments can introduce a more critical perspective relevant to ESD. Natural hazards are often considered in terms of fatalities and the damage affecting human populations. In this sense, humans are seen as victims of 'nature'. However, a close look at the human-nature interrelation shows that human activity sometimes intensifies the risk. Whereas landslides have a natural dimension (geology, slope, heavy rainfall or type of vegetation), the related risks can be enhanced by human activities such as deforestation or the digging of a road, which destabilize the fragile equilibria of a slope. Human activities can also reduce the mitigating effect of ecosystems in the face of certain risks. If mangroves along a coastline are destroyed to develop tourism-focused infrastructure and boost a local economy, the natural protection they offered against tsunamis is

reduced, increasing vulnerability. In the case of the landslide and the tsunami, the hazards can no longer be considered only 'natural'. This holistic understanding of natural hazards is of central relevance when reflecting such issues to steer them toward sustainability.

A textbook writer can also use geography to contribute to ESD by looking at the topic of natural hazards through the lens of actors, thus focusing on vulnerability and risk management. Issues of inequality can be addressed by looking at reasons why an earthquake has more impact in Haiti than in Japan, or why certain groups within a population are more exposed to the risk of a volcanic eruption. Often, a lack of alternatives pushes poorer people to settle in risky places. In the case of an emergency evacuation of a city, under-privileged groups might be exposed to risk for longer if the government fails to organize public transport for people who do not own cars. They may also lack access to important information communicated through means not accessible to everyone. This highlights how socio-economic issues of resources, power and governance influence vulnerability. Vulnerability can also increase according to the meaning people give to a certain place, which might explain why they are prepared to live in riskier areas. Understanding these issues helps highlight alternative options for managing risk by taking into consideration people's beliefs and elements of social justice, global citizenship and peace.

In this example, content is organized around geographical concepts such as interrelations (human impact on nature and vice versa), place (looking at hazards in Haiti and Japan, or at the meaning given to a place exposed to a risk), space (volcanism happens mostly along the limits of tectonic plates, governance and economic power influence vulnerability) and scales (equity in risk management at local and international levels within societies). Keeping these in mind and highlighting their relationships is one specific contribution of geographical education to the complexity inherent in ESD. It rejoins the idea that addressing a topic in such a holistic way is a base for training the system-competence of learners. Students have to be able to 'read' and 'write' the world as a system that is composed of sub-systems

linked by a complex set of relationships (see Rempfler and Upuhes, 2012). The German Association for Geography (DGfG, 2007) considers this system competence to be the core of geographical education and sees it as making a central contribution to ESD, saying: 'Learners can only participate in SD if they recognize and understand complex and global relationships' (Riess and Mischo, 2010, and Rost et al, 2003, in Rempfler and Upuhes, 2012). The geographical content presented in the textbook has to contribute to this system competence.

We will now address the fact that school geography has, in some parts of the world, built up a distinctive pedagogy that contributes to ESD (Smith, 2013).

## 1.2.2

### Which features of geographical pedagogies contribute to ESD?

*Geographical investigation both satisfies and nourishes curiosity. Geographical perspectives help deepen understanding of many contemporary challenges such as climate change, food security, energy choices, overexploitation of natural resources and urbanization. Teaching geography serves several vital educational goals. Building on people's own experiences, learning geography helps them to formulate questions, develop their intellectual skills and respond to issues affecting their lives. It introduces them not only to key 21st century skills but also to distinctive investigative tools such as maps, fieldwork and the use of powerful digital communication technologies such as Geographic Information Systems.*

*International Charter on Geographical Education, 2016, p. 5*

Three central elements of geographical education can be highlighted from this paragraph: the importance of 'investigation', the idea of having

a 'geographical perspective' on current issues and the evidence of 'building on people's own experience'.

#### The central role of investigation

Investigation has played a central role in geography since the origins of the discipline, leading to 'a practical and empirical approach concerned to collect and present the facts' (Matthews and Herbert, 2008, in Morgan, 2013, p. 279). A reliance on self-organized methods of acquiring knowledge is crucial to ESD, so giving learners the opportunity to practise geographical inquiry is one of the ways in which geographical education contributes to ESD. This includes questioning a spatial reality to identify its central issues, gathering information from a variety of sources, practising fieldwork, evaluating the information gathered, putting it into perspective with established 'scientific' knowledge and communicating the findings (see DGfG, 2012; Smith, 2013; Ministry of Education Singapore, 2016). Fieldwork, as an important characteristic of geographical investigation, encourages learners to explore elements of their everyday lives and surroundings, thus developing a link to local issues

*Giving learners the opportunity to practise geographical inquiry is one of the ways in which geographical education contributes to ESD*

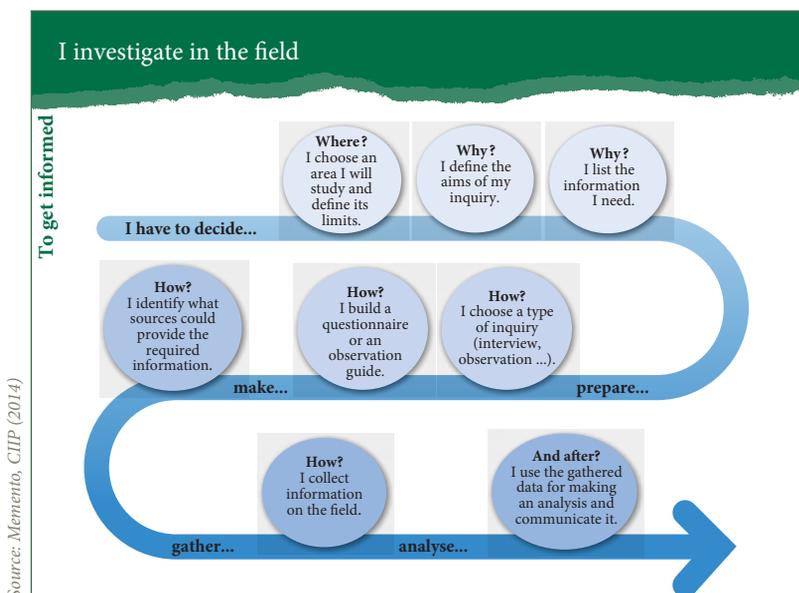


Figure 3: Steps for making an inquiry

and contributing to a sense of ownership and responsibility vital to ESD. Maps and graphics can be a basis for inquiry, as well as a result of it. They are powerful tools in understanding the spatial dimension of an issue as well as synthesizing and communicating complex and sometimes contradicting data. This emphasis on the visual synthesis of geography makes a key contribution to tackling the complex issues inherent in ESD and is strengthened by the emergence of remote sensing and geographic information systems. Moreover, as maps and other visuals reflect the worldviews of the people who made them, a critical point of view on how an issue is represented can be developed. This encourages a critical reading of sources of information.

*Maps and graphics can be a basis for inquiry, as well as a result of it. They are powerful tools in understanding the spatial dimension of an issue as well as synthesizing and communicating complex and sometimes contradicting data. This emphasis on the visual synthesis of geography makes a key contribution to tackling the complex issues inherent in ESD*

Textbook authors need to adopt a pedagogy that works on this kind of procedural knowledge. This should include tasks that enable learners to identify a geographical issue, interoperate and create maps, work with methodologies to gather information and then compare the information they have collected with stabilized knowledge. Figure 3 gives an example from an existing textbook, showing the steps to be taken for leading an inquiry in the field (see also fifth ESD-compatible existing example in section 3.2).

### Learning to think as a geographer

The importance of 'having a geographical perspective', as mentioned in the 2016 charter, echoes a shift in geographical education from 'learning about geography' towards 'learning to think as a geographer' (Lambert, 2004; GA, 2009; Reinfried and Hertig, 2011). To plan a new district on a map in groups and to observe that a place is shaped in various ways according to the values of those who plan it; to debate the efficacy of using biofuel according to its impact on societies and the environment at different spatial scales; and to identify an interrelation

between the introduction of a new technology and a change in surrounding ecosystems are tasks that mobilize geographical facts while training students to 'reason geographically'. Learners are progressively able to mobilize the core concepts of the discipline to analyze a situation from a geographical perspective, which echoes the idea of system competence seen in the preceding sub-section. Training for such a geographical perspective contributes to ESD because it tackles the inherent complexity of sustainability issues. It looks at conflicting interests or possible synergies in a given space, opening the way to the negotiation process. From there, to take the idea of participation central to ESD seriously, learners can reflect on what this could mean for 'acting geographically', even if the school setting does not always inherently foster this action competence. It is, however, possible to study and reflect on possible alternative developments and their implication on space and to identify strategies to implement them. Some projects even allow learners to 'train in participation' by implementing a project within the school or the local community but this can only be suggested in a textbook.

For textbook authors, this means adopting a pedagogical approach that trains these ways of 'thinking geographically', creating tasks that ask learners to analyze a sustainability issue under a geographical perspective and work on 'questions of geography' as shown in Figure 4. These questions, echoing what was put forward in section 1.1, can be: Where is something located and why? What patterns and processes can be observed in space? How are society and the natural environment interrelated? What spatial actions have been taken by which actors and with what representations? At what spatial scales? (see sources at the bottom of Table 1). Making the link to participation implies working with dilemma situations fostering a negotiation, or situations in which learners have to decide which spatial action to take while reflecting on the consequences of their choice and on strategies they would implement for achieving their spatial action. More examples are given in sections 2 and 3.

### Building on people's own experience

The third point mentioned in the paragraph from the 2016 charter quoted above talks about how school geography is linked to learner-centred approaches – 'building on people's own experience'. The idea is not to blur the limits between 'objective' knowledge and learners' preconceptions, also called social knowledge, which is a risk evoked by Firth (2011). The idea is to help create a link between individually lived geographies and consolidated geographical knowledge, and between locally 'lived' issues and global phenomena (see sub-section 1.2.3). This implies that we recognize the need to include the learners' own experiences and geographies (Holloway and Valentine, 2000) and

give them opportunities to start from there to train constructive critical thinking, creativity and participation.

The elements tackled in this sub-section are summarized in Table 1. Two distinctions can be made within these elements:

- Some are cross-curricular and can be found in other disciplines, while others are more specific to geography.
- Some relate more to 'ways of thinking as a geographer', whereas others can be considered methodological skills.

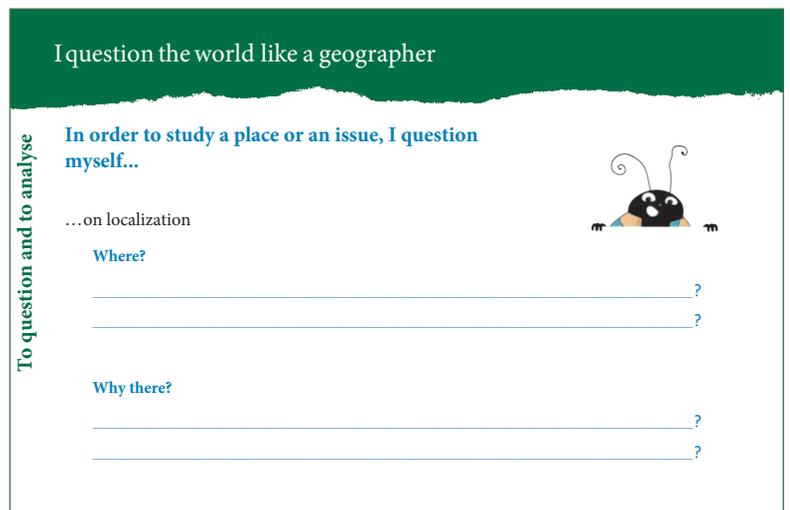


Figure 4: Questions to help students look at an issue from a geographical perspective

Table 1: Characteristics of geographical education that can contribute to ESD

	Cross-curricular but under a geographical perspective	Specific to geography
<b>Ways of thinking as a geographer</b>	<ul style="list-style-type: none"> <li>• Ask questions and identify important issues, thus questioning the status quo</li> <li>• Look at things from different, multi-perspectives and points of view</li> <li>• Relate local experience to global phenomena</li> <li>• Develop an informed opinion and take a stand</li> <li>• Imagine future options, examine side-effects and consequences of planned actions</li> <li>• Take action at individual, collective and political levels</li> </ul>	<ul style="list-style-type: none"> <li>• Study and explain localizations (why things are where they are)</li> <li>• Identify processes and patterns visible in space</li> <li>• Consider various spaces as a system in which humans and nature interact</li> <li>• Identify actors and their influence on space, as well as their private, social or political sense of place (influence of values)</li> <li>• Look at an issue at different scales and at implications for people and the environment at each scale</li> </ul>
<b>Methodological skills</b>	<p>Acquire up-to-date knowledge:</p> <ul style="list-style-type: none"> <li>• Collect and structure information</li> <li>• Process, interpret and evaluate (even contradictory) information</li> <li>• Develop generalizations</li> <li>• Represent (statistical) data</li> </ul>	<ul style="list-style-type: none"> <li>• Go in the field and make enquiries</li> <li>• Read and make maps, spatial models and other graphic representations to visualize multi-dimensional environmental and social issues, being conscious of the influence of the context in which they have been made</li> </ul>

Sources: Based on the 1992 and the 2016 International Charters on Geographical Education, the 2007 Lucerne Declaration on Geographical Education for Sustainable Development and the work of authors such as Haubrig (2007) and Reinfried and Hertig (2011)

## 1.2.3

## Reflecting on geographical knowledge for ESD

A textbook author can also include a reflection on geographical knowledge itself and make learners aware that it is 'socially constructed' (Morgan, 2013, p. 274): 'Geographical knowledge does not innocently reflect the "real world" but instead reflects the subjective interests of geographers which are influenced by values of given societies in given times'. This challenges a prevailing idea that there is an objective 'real world', which is studied by geographers to produce 'knowledge' that is then transmitted to students in schools (ibid. pp. 273–274). The debate around the human origin of climate change clearly shows how knowledge production can be at the heart of societal discussion. In some cases, governments can choose to focus on voices from scientific margins to avoid questioning present economic practices, thus influencing which knowledge should be considered 'true'. In the case of natural hazards, it can be interesting to question why these hazards are defined as 'natural'. Perhaps it is easier to adopt a fatalistic point of view that emphasizes natural phenomena than to question economic and political choices that may increase risk and/or vulnerability. Therefore, making maps and 'writing' geography in textbooks, in effect, plays a political role. This should be dealt with consciously and looked at by the textbook author on the one hand, and integrated in such a way that the learners become aware of it on the other. This is true as early as in primary school – where pupils start working on their sense of place, citizenship and social engagement – and remains valid all through the school years as learners develop their own images of the world and create their own personal geographies. According to this perspective, the idea of 'critical school geography' (Huckle, 1997), which promotes critical thinking on geography itself as a core target of geographical education, is in line with the critical thinking at the core of ESD.

However, questioning geographical knowledge should not mean drifting into relativism and 'alternative facts' while ignoring the importance of existing knowledge built over a long period by a community of researchers and agreed upon by major parts of society. This process leads to a certain 'objectivity' of knowledge (see Young, 2008; Young and Muller, 2010; Firth, 2011; Morgan, 2013), giving it the legitimacy of being what is studied at school and having the power to go beyond personal experience. It is only when you know a lot about natural hazards that you can question whether they are 'natural'. It is in this tension between acquiring a deep

*It is in this tension between acquiring a deep geographical knowledge and being able to question that knowledge that a balance advantageous to ESD is to be found*

geographical knowledge and being able to question that knowledge that a balance advantageous to ESD is to be found. This tension also leaves space for integrating community knowledge in addition to the more classical and critical knowledge (see Figure 4 (Gutstein, 2007) in the Maths chapter). This is a central issue for ESD because it makes the link to local issues and contributes to relevant knowledge of SD. It is also central to geography education itself because 'formal, academic geography that has become institutionalized is not the only form of geographical knowledge' (Bonnet, 2008, in Morgan, 2013, p. 279).

## 1.2.4

## Conclusion: the importance of achieving the right blend of content and pedagogy in geographical education for ESD

School geography has the potential to contribute greatly to ESD through its content and pedagogical approach. To maximize geography's potential, it is important to achieve the right blend of content and pedagogy from the outset. Subject-centred and learner-centred approaches must be considered together, not as opposing poles. The examination of the ecological-social relationship and its dynamics within space can be enhanced through a pedagogy that allows learners to question, examine, discuss and have different opinions, even on geography itself. This enables geographical education to contribute to greater democracy at local and global levels and to work to achieve ecological sustainability and peace.



[www.wledna.tn/enfant-3-12-ans/il-veut-de-plus-en-plus-dautonomie-que-faire.html](http://www.wledna.tn/enfant-3-12-ans/il-veut-de-plus-en-plus-dautonomie-que-faire.html)

Figure 5: Content and pedagogy are two intertwined aspects of the same approach to geography

The rest of this chapter will use tools and examples to provide a structured way to address the link between geographical education and ESD.

## 2.0

## Getting tangible: how to embed ESD in geography textbooks

As stipulated in the Introductory chapter (see section 1.5.1), school systems and their textbooks vary worldwide. For example, certain countries focus on factual knowledge while others concentrate on competencies. Related learning objectives vary according to the context. To remain as inclusive as possible, while taking the idea of blending content and pedagogy seriously, the development of textbooks is addressed in this section through a double perspective. One approach considers ways of working with geographical content in coherence with ESD, the other looks at ways of orientating geographical tasks along ESD pedagogical principles or guidelines. To maximize the potential of geographical education for ESD, both approaches should be considered in an interrelated way. This means that embedding ESD in geography textbooks is not only a matter of working with a certain type of geographical content, but also a matter of using pedagogical approaches consistent with ESD.

This mingling of both approaches (content and pedagogy) helps to avoid the transmission of sterile information and mechanical application of factual knowledge devoid of meaning and contextual relevance. It can contribute to developing geographical competencies<sup>5</sup> relevant to ESD, as shown in Figure 6. Having two possible ‘entries’ provides enough flexibility to embed ESD coherently with contextualized learning objectives, which will have to be defined by textbook authors according to local specificities.

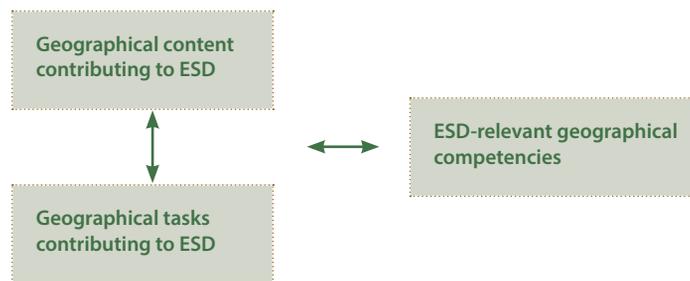


Figure 6: Combining content and pedagogy to develop ESD-relevant competencies

*Embedding ESD in geography textbooks is not only a matter of working with a certain type of geographical content, but also a matter of using pedagogical approaches consistent with ESD*

To address these two possible ‘entries’, a tool articulated in two parts has been elaborated (see overview of the embedding tool). One part suggests criteria for working on geographical content so that it is relevant to ESD (see Spider-web 1), the other part triggers a reflection on geographical tasks that foster ESD (see Spider-web 2). After a general explanation relating to the spider-webs, an example on the topic of water illustrates how it is possible to use them. A third sub-section briefly presents three complementary tools of interest in ESD to show possible articulation between existing tools and the approach we present here.

### How to use the spider-webs<sup>6</sup>

The aim of the two spider-webs is to provide an orientation for authors wanting to embed ESD in their geography textbook. They are a thinking tool designed to take an ESD-relevant perspective while developing the textbook, rather than a normative imperative to which every part of the textbook has to correspond rigidly. This flexibility is needed for several reasons:

- The different branches of the spider-webs are related to one another, which implies, in general,

<sup>5</sup> See the definition given in the Introductory chapter.

<sup>6</sup> The idea of using spider-webs in the field of ESD was developed by a team of Swiss researchers wanting to embed ESD in teaching practices (Kyburz-Graber, Nagel and Odermatt, 2010 and Kyburz-Graber, Nagel and Gingins, 2013). The team has developed a ‘content’ spider-web with ESD-relevant ‘thematic areas’ such as ‘ethics and culture’ or ‘natural resources’ as well as a ‘pedagogical principles’ spider-web similar to the one presented in this chapter. The tool was tested by around 130 teachers before being published. In this chapter, the ‘content’ spider-web has been adapted so as to work on aspects of geographical content contributing to ESD, and the ‘pedagogical principles’ spider-web has been adapted to match the competencies presented in the Introductory chapter.

that more than one branch of the spider-web is addressed at a time. For example, looking at the 'human-environment interdependencies' usually implies looking at 'actors' and their spatial actions (Spider-web 1). Or thinking of alternative options for the future ('facing the future with creativity') requires critical examination of the present situation ('critical thinking') (Spider-web 2).

- Following the same logic, the content and tasks of the textbook can be categorized in various ways and thus address more than one branch of the spider-web. For example, understanding why volcanoes are concentrated along the limits of tectonic plates can be categorized under 'localization' (where and why there?) as well as under 'patterns and processes' (there is a system in the fact that volcanoes concentrate along the limits of tectonic plates). In the same way, population settlements and dynamics can be looked at under these both perspectives ('localization' and/or 'patterns and processes'). For tasks, a roleplay taking into consideration diverse perspectives can address the principle of 'critical thinking' and/or the principle of 'dealing with values'. If the aim of the roleplay is to find a common solution, the principles of 'collaboration and communication' and 'facing the future with creativity' are addressed.
- It is also possible that some elements of a chapter are seen rather as a prerequisite for looking at an issue under a geographical perspective and so do not fit systematically in the spider-webs. For example, if working on climate change, understanding how the greenhouse effect works and pointing out the specifics of present climate changes compared with previous natural variations could be seen as a prerequisite for looking at climate change under a geographical and therefore spatial perspective. Or, if a link to spatial logics is integrated (for example, climatic zones), this point could correspond to the criteria 'patterns and processes'.

#### What the spider-webs allow:

- They help authors keep an overview of the type of geographical content and pedagogical approaches used. It prevents, for example, a chapter omitting to look at the underlying value of a given spatial organization within a sustainability issue. They provide a base that helps authors to take into account complementary perspectives of a geographical issue or a complementary set of tasks to contribute to ESD as much as possible. This does not mean that the aim is to tackle every aspect of the spider-webs at all times, which is difficult at the task level and could lead to superficiality. However, looking at 'patterns and processes' taking into account 'human-environment interrelations' and the role of 'actors' in these patterns and processes contributes more to ESD than looking at patterns and processes alone because it leads to a deeper

understanding of a SD issue. See completed Spider-web 1 for content and completed Spider-web 2 for pedagogical principles.

- They help set a focus that could enhance the contribution of a given chapter or task to ESD. For the natural hazards topic in section 1.2.1, looking in detail at the 'human-environment interrelations' as well as the underlying values ('dealing with values') of given spatial actions can lead to a critical reflection ('critical thinking') of the human role in natural hazards. This contributes more to ESD than if the hazards are simply considered to be 'natural'.
- They can be used to work at two levels: chapter (the outline of the chapter) and task.

### 2.1

## How to select geographical content for ESD – content criteria

Influential charters and declarations (Haubrich, 2007; IGU-CGE, 2016) state that it is unwise to seek a consensus on a global geographical curriculum, heterogeneity being too important. Of course, major topics such as climate change, migration, natural hazards, urbanization or water might appear in most school curricula. However, the intention of having a 'content' selection tool is to allow the presentation of any geographical topic relevant to the context in which the textbook is written and to examine it from a specific angle. The following criteria presented have been derived from the contributions of geographies to SD as discussed in the first section of this chapter and echoed in the 'ways of thinking as a geographer' already identified in Table 1.



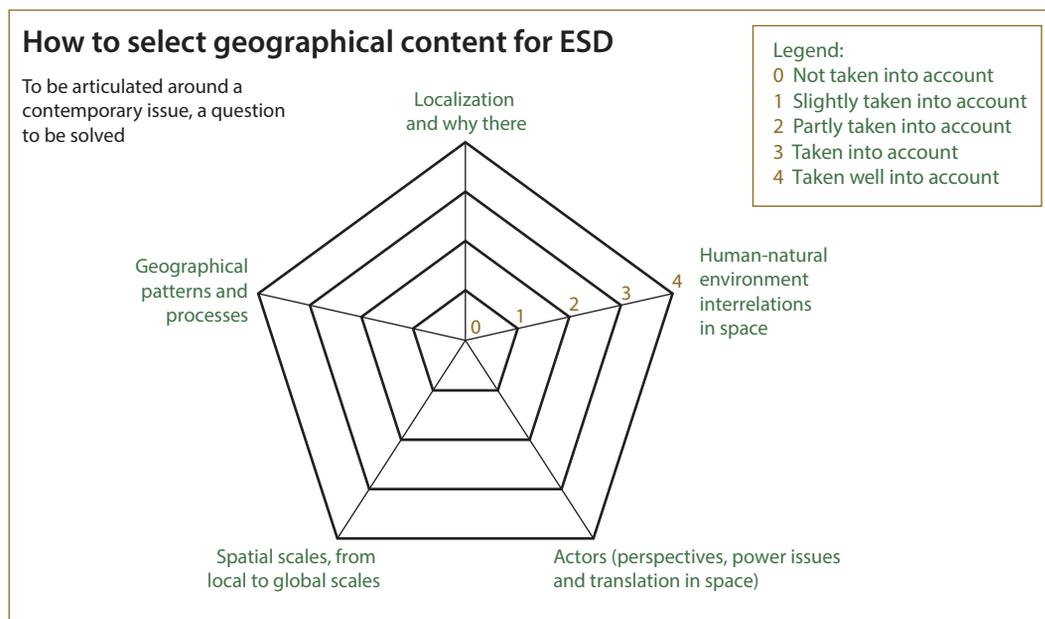
*"So it's agreed that we spread this wretched urban mess spatially, in a fair and equitable manner"*

Table 2: Characteristics of geographical education that can contribute to ESD

Geography textbooks develop 'ways to think like a geographer' when they...	The contribution to SD and, therefore, to ESD
<p>Allow learners to understand why things are located where they are: <i>localization and why there?</i></p> <p>Example: Most urban areas are located near a lake or a river because they provide water and transport possibilities. Most volcanoes are located along merging or diverging tectonic plate limits where magma comes up to the surface.</p>	<p>Every sustainability issue has a spatial localization. Understanding the logic of this localization helps anchor the issue in a local reality and its specificities. This is to be taken into account when thinking of alternatives for SD. Geography specifically addresses such localization issues.</p>
<p>Illustrate the interrelation between humans and the natural environment by looking at influences of and on spaces: <i>human-environment interrelation in space.</i></p> <p>Example: Climate change affects human activities that, in turn, affect the climate.</p>	<p>This human-nature interrelation is at the core of SD and allows us to see things as a system where elements are intertwined. Geography specifically illustrates these interrelations in space.</p>
<p>Take into consideration the interrelation among human societies/groups/individuals by pointing out different actors and the impact of their worldviews and decisions on space. This implies that underlying values and power relationships and their influence on spatial actions have to be made explicit because not every actor has the same values or the same decision power. Learners can be considered one of these actors: <i>actors.</i></p> <p>Example: Houses of rich people take more space and are situated on better locations than the huts of poorer people, thus showing power relationships in space.</p>	<p>SD is about choices, values and participation so it is essential to look at actors and governance issues in order to understand their impact on space, the way they are affected by space, and what their conceptions concerning issues of sustainability are. Taking into account different perspectives, conflicting interests and ways of solving them contributes to addressing issues of peace and social justice. Geography specifically makes the link between the choices of actors and their impacts on space.</p>
<p>Reflect issues at different spatial scales, from the local to the global and vice versa, and make interactions between these scales clear: <i>spatial scales.</i></p> <p>Example: Biofuel might seem to be a good solution for mitigating climate change when considered at the scale of a western country, but is a problematic solution when considered at a wider scale because it challenges food production in most countries that produce it in large quantities.</p>	<p>In a globalized world, a local action can have a global impact and vice versa, which implies it is not enough to address a topic at one scale. Moreover, SD as well as global citizenship integrate the idea of solidarity at a worldwide level, which can be taken into account by linking different scales and groups of people. Geography specifically brings this ability to examine topics at various spatial scales.</p>
<p>Look at spatial patterns and geographical processes in a dynamic perspective. This includes patterns of polarization and diffusion of phenomena but also the evolution and organization of space over time: <i>patterns and processes.</i></p> <p>Example: Economic activities of the tertiary sector have been concentrated in city centres but are now frequently located in the suburbs, implying other mobility behaviour.</p>	<p>SD is also about linking local processes to broader patterns leading to possible generalizations and the identification of unsustainable practices at a broad level. Moreover, SD is not a static concept and is, therefore, a process. Geography contributes to this understanding by identifying patterns and evolving spatial organization.</p>

Based on these criteria, the working tool presented below has been developed to help select geographical content for ESD. To give meaning to the content and avoid a 'pile up' of knowledge that might make little sense to students, it is important to articulate content either around a contemporary issue (is water a human right?) or a question to be

solved (how can we be fair in water management?). This can also be articulated around a case study (is it possible to resolve the tensions around the Mekong river?). See Fabre (2014), Pache and Hertig (under press) and the Science chapter of this guidebook for further insight.



Spider-web 1:  
A tool to help textbook writers select geographical content relevant to ESD

As an example of how the tool can be used, we will work out the topic of water showing a possible implementation at the level of a chapter and at the level of a task. The contribution to ESD is made explicit.

### 2.1.1

## Example of selecting content for the topic of water

### — CHAPTER LEVEL

Question along which the chapter can be articulated: How can we manage water in a way that benefits most people without depleting the resource?

#### Localization: Where and why there?

Explain where water is to be found and why it is found there at a global (water stock in the poles) and/or a more local/regional level (shape of the water basin and types of rocks constituting it, rainfall and/or presence of glaciers, lakes created by human intervention, such as dams or dykes, and so on).

*Contribution to ESD:* By reflecting the localization of water availability and explaining the water cycle, geography gives information on the repartition and renewal capacity of a resource. By appreciating the subtlety of those mechanisms and the limits of the system, value can be given to water. A good understanding of water availability locally and worldwide is of crucial importance when identifying (un)sustainable practices or thinking of possible future scenarios and related alternative solutions (for example, what if all glaciers disappeared as a result of climate change? Would human intervention, such as a dam, solve the problem in place X?).

#### Which human-environment interrelations?

Show the link between the presence of water and human activities illustrated in space (for example, urbanization, fishing settlements, industrial activities and energy production, transport infrastructure and so on, but also water-related risks and related management measures) and the impact of human activities on water (for example, control of riverbeds through the building of dykes and dams that

affect local ecosystems, pollution and its impacts on aquatic ecosystems and surrounding inhabitants, over-consumption of the resource because of demographic pressure, inefficient irrigation habits or water-demanding activities, such as golf courses in dry countries). Give examples of unsustainable and sustainable interrelations.

*Contribution to ESD: By understanding water as a system of which our societies are a part, and seeing different uses of water, learners become aware that water availability is not only a matter of the quantity of water present but of how it is used. They also understand that they, as consumers, are part of the system and that all society is dependent on the resource. Looking at the human-environment interrelation contributes to a holistic understanding of the issue, pointing out the consequences of certain actions on the environment but also on societies in turn.*

### **Which human-human interrelations, which actors?**

Make clear that there are numerous actors, with different perspectives and values, who need and/or deal with water, who have different degrees of power to interfere with the access and management of the resource. Pointing out different perspectives, power relationships and how these are visible in space is a crucial element when talking about water-management conflicts and reflecting alternative solutions. A multinational company exploiting a spring, for example, has different intentions to a local community exploiting the same spring for its own needs. The company may have more power than the local community, depending on the position of the government and existing regulations. The impact on space could be that the local community might have to move and that a water-treatment plant would be built near the spring. Another example can be given of how such conflicting interests have been solved in a peaceful way within the frame of sustainability, showing what impact this has on space.

*Contribution to ESD: This raises awareness that water-related infrastructures reflect values and power relations contribute to seeing the world as a system that is influenced by the merging or conflicting interests of individual and collective actors within a given space. It helps to address problems at the core of sustainability issues and to identify the actors at the root of spatial action that can support or hinder change. It also helps to reflect solutions, taking into account issues of peace and social justice while looking at water distribution.*

### **At what spatial scales?**

Point out that water management can be examined at different spatial scales and may make different impacts at these scales. For example, the impact of constructing a dam might be considered positive at a regional or national level because it could provide electricity or water to a surrounding area and thus enhance the quality of life for part of the population without emitting CO<sub>2</sub>. However, it might make a negative impact on existing ecosystems and local human communities as a result of flooding. At an international level, the dam might prevent enough water reaching areas in need in a neighbouring country.

*Contribution to ESD: Being aware that the construction of a dam has diverse impacts at various scales helps to tackle water management as a complex and systemic issue. Considering the environmental and social impacts at various scales diminishes the risk of taking decisions valid only at one scale – and which might be unsustainable. It helps learners to think about compensatory measures that take into account biodiversity and social justice if the dam is built.*

### **What dynamic (patterns and processes)?**

Show that the presence of water attracts human activities but that too great a concentration of these activities leads systematically to the depletion of the resource in areas where it is not abundant enough. As a consequence, conflicts between various water users can arise. Make visible the fact that spatial issues and infrastructures related to water have changed over time and that the development of various economic sectors, such as tourism, has increased pressure on water in many countries. For example, Brazil's position as an emerging market has increased its construction of hydro-dams. Complete with examples of positive evolution towards greater sustainability.

*Contribution to ESD: Working with patterns affords a 'big picture' vantage point and highlights recurrent logic related to water availability, distribution and use. The process-oriented nature of geography helps us to take into account the possible evolution of these patterns. Both elements are of great use when identifying unsustainable patterns of water consumption and when thinking or planning future developments in sustainable water management.*

The chapter would conclude with a synthesizing part in which the initial question would be addressed. In this example, all the aspects of the spider-web have been addressed. The choice of the content tackled within each 'branch' will be influenced by the expected learning outcomes, the chosen general question to be answered and the

pedagogical principles addressed. If future thinking is to be worked on, the chapter should include more examples of sustainable ways of addressing water management. Having set the general framework for the content of a whole chapter, the same logic would apply for reflecting on the content of specific tasks, as shown in the next section.

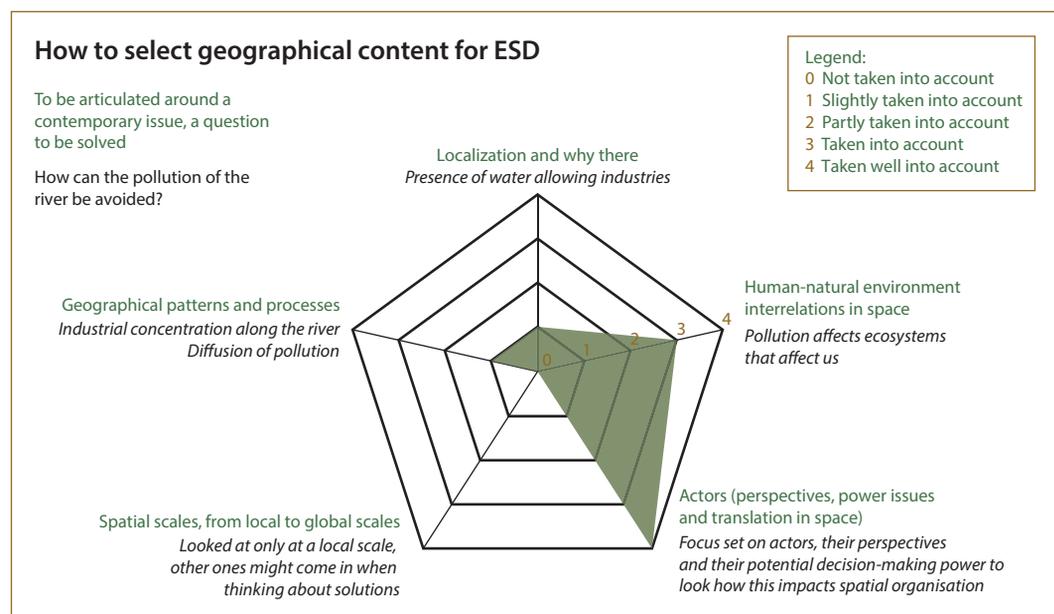
2.1.2

## Example of selecting content for the topic of water

– TASK LEVEL

- Situation (as text):** The factories on the river X use water for processing their goods, which are successfully sold for export, providing a strong financial income for the local communities. However, these factories are polluting the river to such a degree that its natural systems are breaking down, adversely affecting the health of all living things that depend on the river – humans included. A decision has to be taken on what to do: the situation cannot continue. The local governance system allows participation of civil society to a certain extent.
- Actors' perspective (in illustration and text):** Pictures of several actors are inserted in the textbook with related texts expressing their perspectives, their relationships with the river and their decision-making power. The factories are represented by economic actors, whose aim is to make money but whose businesses depend on the right to use the river, granted by the local government. They have a lot of power because they fostered the area's economic development. The local government representatives depend on the industrial activity because it brings in tax money. They also have to ensure the health of their community and ecosystems, be it only to secure their re-election. They have the power to intervene through legal means by not renewing the right to use the river. The members of the local community are affected by pollution and fear for their health. But quite a significant amount of people are employed by the factories and some wealthy community members can afford and appreciate the produced goods. The community is weak in terms of its power but can wield influence if its members gather together to exert pressure at a political level or if factory workers decide to strike.
- Impact on space (as a map):** A schematic map of the area showing geophysical aspects, existing industrial infrastructures around the river and localization of the communities.

The spider-web corresponding to this example would look as follows and is to be articulated with the completed Spider-web 2 because the content presented here will be the base for a set of related tasks.



Spider-web 1 completed:  
Shows the tool being used to evaluate how the chosen geographical content at the level of a task contributes to ESD

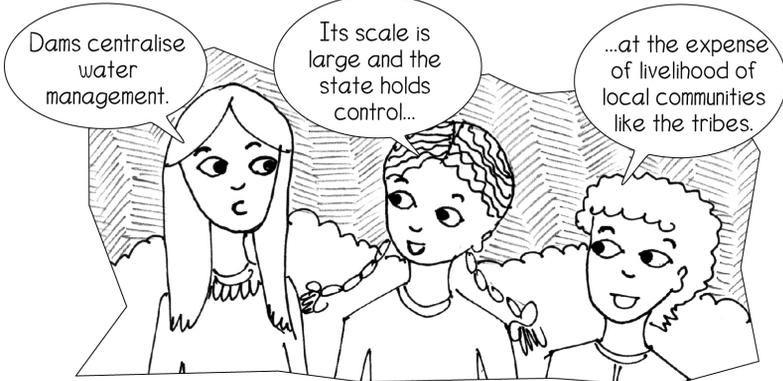
As already explained in 'How to use the spider-webs' at the beginning of section 2.0, more than one criterion is generally fulfilled, even at the level of a task, but not all criteria are considered because it is difficult to take into account all aspects at the task level. Ideally, the aim would be to have tackled all elements in an articulated way while completing all tasks within the chapter.

The 'content' spider-web can also be used to analyze the content of an existing textbook to identify how it is ESD-compatible, for example, when considering a new adapted edition.

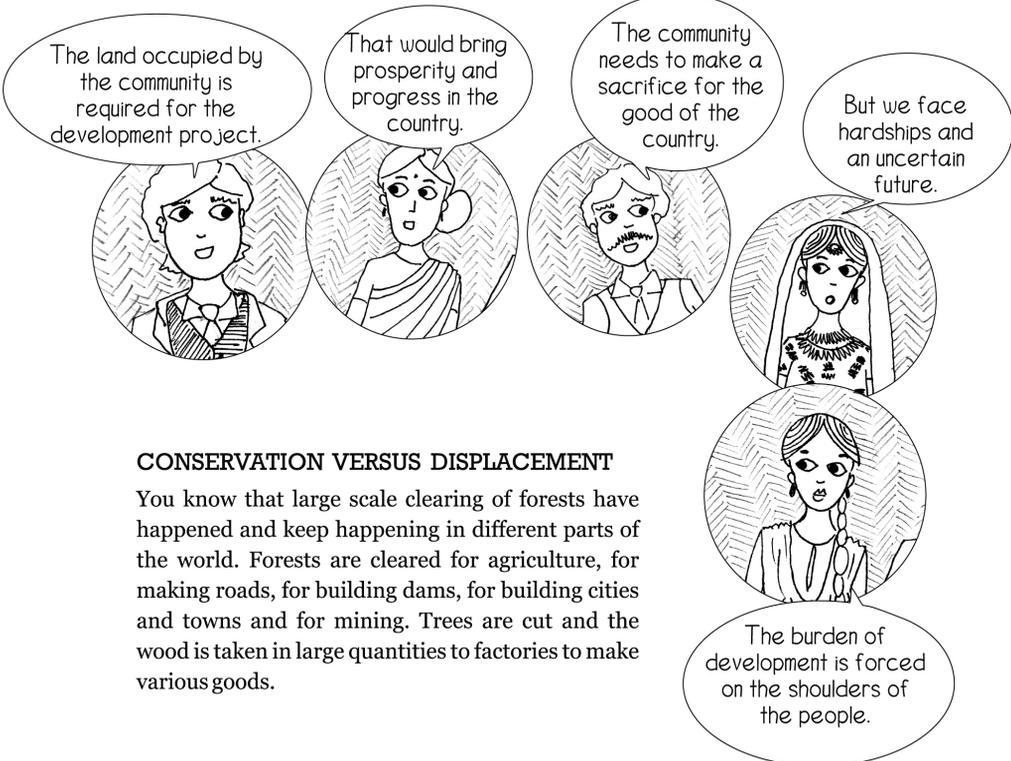
Figure 7 shows an illustration from an

existing textbook, *Sprout: A Social Geography of Rajasthan*. The example focuses on actors and their perspectives in relation to the construction of a dam. However, it also reflects the situation at different scales and looks at the human-environment interrelation by showing environmental impacts. Starting from such geographical content, it is easy to embed ESD by imagining tasks inspired by the pedagogical principles described in the next section. See also the example showing how, based on existing content in a textbook, a set of tasks can be added so as to enhance the embedding of ESD (see sixth example in section 3.0).

They have largely been displaced in the process. For example the Mahi Bajaj Sagar dam in Rajasthan displaced 38, 400 people and 76% of them were from tribal communities.



As in other places people have organised in Rajasthan to resist the displacement that is forced upon them. Here is a discussion between the people and state officials:



**CONSERVATION VERSUS DISPLACEMENT**

You know that large scale clearing of forests have happened and keep happening in different parts of the world. Forests are cleared for agriculture, for making roads, for building dams, for building cities and towns and for mining. Trees are cut and the wood is taken in large quantities to factories to make various goods.

62

Figure 7:  
Geographical content  
contributing to ESD

## 2.2

## How to create tasks in geography that embed ESD – pedagogical principles

*Learner-centred, fostering autonomy, transmitting differentiated worldviews, opening to interdisciplinarity: some general pedagogical principles for ESD textbooks*

The previous section has shown how the choice of geographical content integrated in the textbook can contribute to ESD. This can be tackled in parallel with pedagogical approaches favourable to ESD. Section 2.2 shows how to mobilize geographical tasks and specific features of geographical education, such as investigation and fieldwork, mapping or working on 'ways of thinking as a geographer' (see Table 1), to make them relevant to ESD. A first sub-section looks at some general pedagogical principles or guidelines that are not specific to but are necessary for ESD. The second sub-section addresses more ESD-related pedagogical principles or guidelines. These echo the competencies presented in the Introductory chapter.

## 2.2.1

### General pedagogical principles

Taking the following general principles into account sets a pedagogical base favourable to ESD:

- The textbook is learner-centred, which means that:
  - The textbook supports teachers in taking into account learners' preconceptions and worldviews. This is important in geography because a sense of place is a very individual matter. As mentioned in section 1.2.3, being learner-centred should not be set in opposition to being knowledge-centred – the textbook supports ways of making links between learners' personal geographies and stabilized geographical knowledge. An example of this is to be found in section 3.2.
  - A link between the learner's language and scientific language is made. One possible way is to include some texts written by young people acquainted with the topic.
  - Abstract knowledge is made comprehensible and meaningful through contextualization (working on local case studies, for example) and facilitating pedagogical approaches.
- The textbook helps enhance the student's ability to become an independent learner (see also the principle of acquiring knowledge in Table 3) and so adopts an approach tending towards constructivism. This implies that the textbook encourages learners to gather some information themselves (such as through fieldwork or conducting internet research) and either presents some blank space for learners to write down their

result or suggests they do it on a separate sheet. In both cases, the teacher is the one validating the information gathered. It might be helpful to have some supporting comments in the teacher's guide, if applicable.

- Geography is about reading and writing the world, so it is essential that the textbook transmits differentiated worldviews that challenge stereotypical visions and negative categorizations. This implies that:

- The wording present in the textbook is chosen carefully to avoid reinforcing stereotypes (see the Languages chapter) and marginalized voices are represented. The word 'underdeveloped' could be replaced by 'less developed from a capitalist perspective' because communities less integrated in the present economic globalization process might have a relation to nature and resource consumption that is much more relevant to sustainability issues than most 'developed' communities. When talking about such communities, it can be interesting to include some texts produced by their members, showing their perspective on mainstream understandings of development.
- The images chosen for the textbook complement the text and challenge stereotypical visions of the world at the level of gender, religion, wealth, development and so on. Maps, in particular, have to be chosen very carefully because they are a powerful means with which to 'write' the world. For example, maps that ignore minorities and so foster the worldview of those in power or reinforce mainstream perceptions (for example, the north-south dichotomy or the importance of GDP as the only measurement of 'development') should be balanced with maps questioning these issues (for example, a map illustrating the Gross National Happiness Index).
- Generalizations should not show only one perspective on an issue, as has been done in this extract:

*The underdeveloped and poor countries are located in Africa and Asia. They are distressed by wars and have no natural resources and no ways of exploiting them. Several of these countries are governed by dictators, who keep the riches for themselves while a large part of their population lives in extremely poor conditions, with no food, no schools ...*

*– Misteri al castello. Libro delle discipline. Per la 5a classe elementare. Geographia: Sviluppo sottosviluppo. Edizioni Il Capitello, p. 328 (translated)*

While part of what is written above corresponds to a certain reality, it would offer a more differentiated perspective if it included positive examples of countries in Africa and Asia, where

functioning governance systems have reduced poverty and where some parts of the population exemplify civil courage and initiatives that everyone could learn from.

- As already mentioned, geography deals with systems by acting as a bridge between the natural and social sciences while focusing on the spatial dimension. It is possible to reinforce this systemic approach by making links to related disciplines (for example, physics when looking at climate change, or history when focusing on processes). Within this guidebook, the exercise on the trajectory of a typhoon in the Maths chapter or the example focusing on bees in the Science chapter would be possible ways of looking at an issue in an interdisciplinary perspective.

In addition to these general principles, the ones that follow relate more directly to ESD and so are particularly relevant when embedding ESD in geography textbooks.



### 2.2.2

## ESD-related pedagogical principles

These ESD pedagogical principles or guidelines are related to competencies presented in the Introductory chapter, with the following variations aimed at reducing the list:

- Solving issues/problems/conflicts is addressed here in the principle of collaboration and communication as well as the one of participation.
- Changing perspectives is included in reflecting on values and critical thinking.

- Thinking and acting inclusively is part of showing solidarity and responsibility. We have named this principle 'bonding and stewardship' because a sense of ownership underlies the idea of solidarity and responsibility.
- The idea of creativity, not present in the original list, has been integrated in facing the future because 'thinking outside the box' is central to finding solutions and considering alternative ways to develop societies.

The articulation of these principles can be seen here in Figure 8.

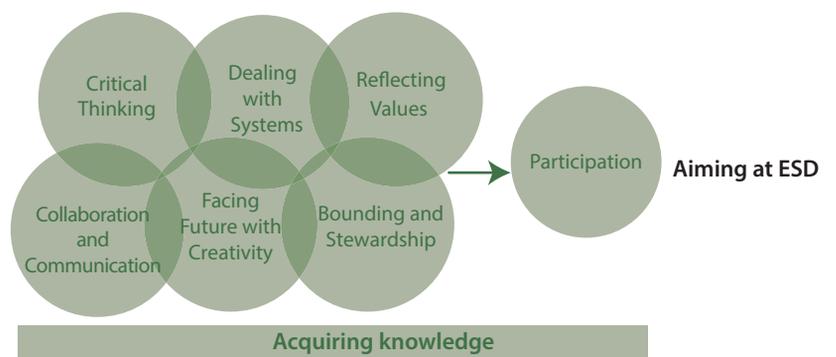


Figure 8: ESD-related pedagogical principles or guidelines

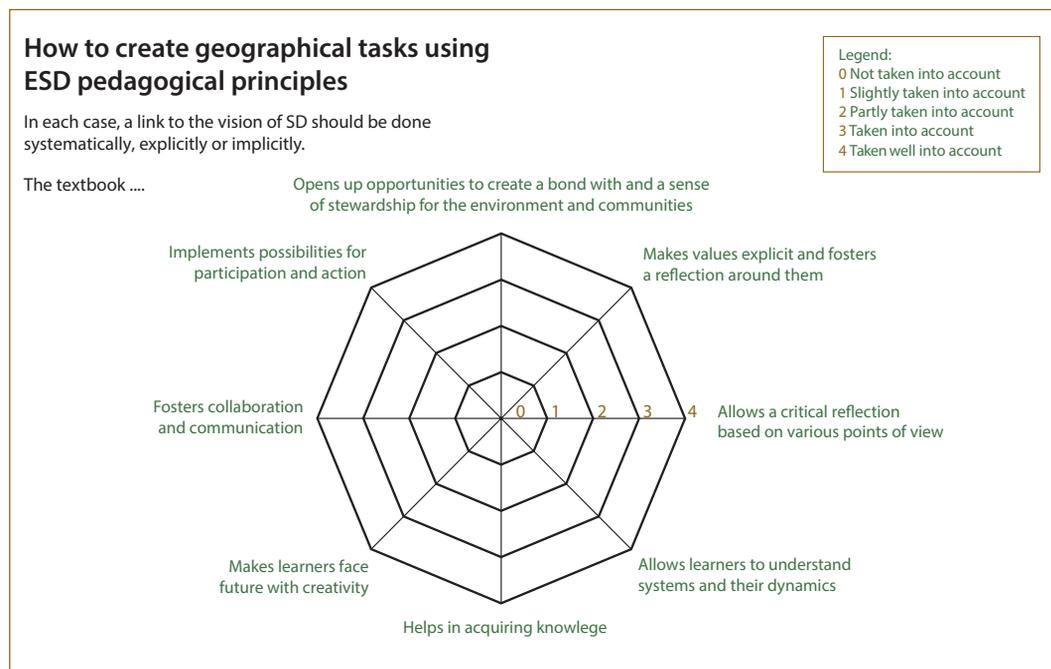
The pedagogical principles presented in Figure 8 are overlapping because they can be combined and nourish one another. For example, having a deep understanding of a system helps a student to look critically at an issue, which might help them to imagine creative alternatives for the future. Eventually, all these principles should contribute to participation because committed action towards SD is central to ESD. The idea of acquiring knowledge underlies all other principles because being able to gather SD-relevant knowledge autonomously is a core issue (Audigier 2011, Pellaud 2011) and relates to all other principles. This transversal principle complements the one about the learner's autonomy mentioned under the general principles. It is not only about learning 'how to solve a task in the textbook autonomously' but about being an independent citizen in a fast-evolving world, where facts that are valid today – as well as current ways of thinking and doing – might soon be outdated.

The following section shows how geographical tasks, based on the pedagogy of geographical education seen in section 1.2.2, can be orientated along these principles to contribute to ESD. This should be done in interaction with the elements relating to geographical content, tackled earlier (see Spider-web 1). Spider-web 2, which addresses the pedagogical principles to be considered, has been developed using the same logic that was applied to the content criteria. As already explained (see 'How to use the spider-webs'):

- Most aspects of geographical education can contribute to more than one of the above-mentioned principles because they are interrelated, Fieldwork, for example, can create a link to a local community and thus foster the idea of bonding and stewardship but can also contribute to dealing with systems and acquiring knowledge.
- The spider-web can be used for an overview of the

pedagogical approaches within a whole chapter or it can help to create individual tasks. In this case, not all principles can be addressed at the same time but can lead to a complementary set of tasks within the chapter.

Here, again, the aim of this section is to suggest pathways that textbook authors could follow in their process of embedding.



*Spider-web 2:  
A tool to help textbook writers create geographical tasks that contribute to ESD*

Table 3: Characteristics of geographical education that can contribute to ESD

The textbook promotes the following ESD-related pedagogical principles	Examples of what it implies for geography textbook authors when working on tasks (non-exhaustive list)
<p><b>Bonding and stewardship</b></p> <p>Connect students to a community and/or the environment, allowing a sense of wonder and empathy as well as physical and emotional belonging so as to enhance their stewardship and their sense of responsibility and willingness to act.</p>	<p>Work with the ‘sense of wonder’ geography education can generate. Use the opportunity that investigation and fieldwork offer to create a link to local surroundings and capitalize of the fact that diverse cultures are studied to give people a sense of global citizenship.</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Give instructions and methods for making surveys, drawing landscapes and/or maps in the field.</li> <li>• Suggest ways of experiencing local geographies (land art, participation in community projects, etc.)</li> <li>• Integrate narratives that enhance the magic of the human-nature relationship or work on evoking empathy for people in other parts of the world.</li> <li>• Pay attention to the aesthetic of textbooks and integrate visuals that can touch the emotional world of learners.</li> </ul>

## Reflecting values

Make underlying values explicit to foster understanding of other people's perspectives but also awareness of possible synergies or conflicting interests. Compare them with the idea of basic needs, intra- and intergenerational equity and a framework of values related to SD, peace and social justice to avoid relativism.

*See the remarks immediately after this table.*

Make underlying values of spatial actions and mapping visible, link them to the vision of SD and discuss the meaning people give to places. For example:

- Ask learners to take a position on a certain spatial issue and leave blank spaces so they can record an argument, making the underlying value of their choice explicit. Then have them reflect their choice on the basis of extracts from the *Earth Charter*.
- Foster roleplay aimed at solving a given space-planning issue. Give the different actors diverse values.
- Make learners plan a new district or a new region according to their values or to given values (for example, social inclusion versus segregation, or beauty versus economic growth). Compare the results and discuss the values that emerged. Identify which scenario best tends towards SD.
- Identify mental models at the root of a spatial situation considered to be unsustainable (see Figure 10: the Iceberg Model).

## Critical thinking

Provide learners with tools helping to identify, understand and question the central and sometimes hidden issues (such as power relationships) of existing situations and ways of life, as well as mechanisms that lead to the successful implementation of sustainable practices (question the status quo and 'look behind the curtain'). Encourage learners to look at different perspectives, including conflicting ones, and build a personal opinion.

Identify patterns and processes, look at different perspectives on spatial issues at various scales and use investigation methods to access different kinds of geographical information. For example:

- Ask learners to identify a central geographical issue related to SD within a given text or analyze a given map.
- Integrate classical 'scientific' knowledge, critical knowledge and informal community knowledge (see section 1.2.3), suggesting ways of articulating them.
- Insert information in the textbook that fosters the understanding of underlying mechanisms. For example, in the case of humanitarian aid, show how competition between NGOs slows the aid process or how countries show their power by promising large amounts of money for aid, promises that are not always kept.
- Ask learners to consider provocative questions such as 'Why is climate change a problem when climate has always changed?' to point out the specifics of the ongoing change related to human activity (see Figure 10: the Iceberg Model).

Give instructions so that learners search the internet for information that is difficult to find, such as the costs of the last football World Cup, make them cross-reference diverse sources and discuss why such information is difficult to find.

## Dealing with systems

Present situations and issues as a system in which nature and societies are intertwined and look at the dynamics of this system while including diverse linear and non-linear interactions. Highlight how societies rely on nature and how nature and societies affect each other.

Use the focus on the human-environment interrelations at different scales to look at the world as a system. For example:

- Integrate tools to help learners explore a local and familiar subject, taking into account different aspects and perspectives and showing how they are linked (see Figure 9: the Sustainability Compass).
- Show ways in which natural systems are sustainable and make learners reflect on what human societies could learn from them.
- Present an unfinished mindmap with the words 'water', 'salad' and 'petrol' and ask learners to link these elements and explain their relationships. Then ask students to reflect on what would happen if the word 'petrol' were taken away.
- Ask learners to invent an alternative ending for a situation/story presented in the textbook after having changed an element of the situation (see also facing the future with creativity).

## Facing the future with creativity

Give room to imagination, divergent ideas and inventions to be explored so that alternative visions of existing situations and ways of doing can be developed. Encourage learners' visions of possible futures and confront them with reality. Train them to anticipate the impacts of present actions on future generations. Teach learners to take advantage of change.

Use the dynamic nature of geography to look at processes and imagine future evolutions. For example:

- Ask learners to draw their vision of how cities will be in 100 years' time, then how they would like them to be. Compare both drawings with the vision of sustainable cities and identify which depiction is nearer to a sustainable city. Identify two measures that could be taken to move towards such a city (link to participation).
- Let learners explore and choose from future scenarios and/or alternatives on given geographical subjects and ask them to mobilize their acquired knowledge to justify their choices.
- Based on factual knowledge presented in the textbook, ask learners to write an article about a specific geographical issue (for example, risk management given a rise in global temperature of 2°C or more; their own life as grandparents observing the changes that have happened in the environment, city, transport, interaction between people, and so on) as if they were journalists in 2100.
- Work with 'what if?' stories, such as 'what if petrol were free/unavailable' or for smaller children 'what if chocolate were free?' Older learners could be asked to draw a diagram showing different levels of consequences and how some of them might be connected (see also dealing with systems).
- Provide half a story illustrating the evolution of a geographical issue up to the present day and let them write the end (once freely, then asking them to take into consideration principles of SD). Compare with existing scientifically based scenarios.

## Collaboration and communication

Help learners to know themselves (for example, their values and goals) and recognize others' values and goals so as to acknowledge diversity. Encourage them to work together towards a common aim, acknowledging the benefits of working together but also the difficulties that can be addressed constructively. Make it possible for learners to elaborate opinions and choices. Train them to communicate clearly about collective analyses and visions or about personal choices and opinions.

Work with the fact that space is shared by several actors and so requires collaboration and communication when being planned and used. Use the power of maps and other graphics for synthesizing and communicating complex information. For example:

- Structure content so as to allow students to work on it in different groups: each group brings part of a 'puzzle' around a common question. With this example, students can work in expert groups (three students work on the environmental importance of water, three on the economic one, three others on related social issues, then the groups are mixed to solve a given problem with their complementary expertise).
- Create an exercise in which learners are asked to reflect on the best ways to achieve different societal aims by choosing between 'collective' or 'individual' measures or both to show the importance of collective solutions.
- Have learners investigate an SD issue and communicate the results as a graphic or a map based on statistics so as to learn visual communication.
- Integrate a geographical situation in which different actors use diverse types of speech (for instance, comic-type illustrations) and ask learners to link the speech to a given context (more or less formal).

## Participation

Let learners take a stand, identify possible opportunities to act and develop implementation strategies: Is there a possibility to act? How would it work individually or collectively? Who can help me? Who do I have to consult? Where can I find help to support my project?

*Remark: although experiencing action can only be suggested by a textbook and has to be realized 'live', identifying strategies and planning a project can be worked on in the textbook.*

Use learner-centred pedagogies found in geography to get learners active, and work on the role of actors in shaping space.

- Elaborate on a situation in which learners are asked to make a collective decision (for example, to have a school garden) after having researched the subject (individual, collective, legal, environmental and economic implications) and considered different perspectives presented in the textbook. Then ask learners to map their project and define steps to implement it (and, if possible, make it happen).
- Ask learners to choose between three action-scenarios facing an environmental issue and identify one measure that would help in making the chosen scenario true.
- Have learners follow the different steps to be taken to implement a project. The textbook would indicate these steps and leave a blank space in which learners can inscribe what that means for their project. The Pyramid Model in Figure 11 can support this process.

## Acquiring knowledge

Help learners to gain SD-relevant knowledge by themselves (individually and in networks), look at it critically and compare it with existing knowledge. Provide methodologies for acquiring knowledge or require learners to generate methodologies.

The central role of investigation in geographical education brings an important added value to working on this principle. Present methods and critical points to be considered for gathering geographical information. It is also possible to include spaces in the textbook to take note of gathered information in a structured way. Possible processes worth explaining could be:

- How do I read and interpret a map/image/cartoon?
- How do I lead an inquiry from the perspective of SD? (See Figure 3.)
- How can I work out questions for an interview and how can I identify relevant people to interview?
- How does the information I gathered relate to existing knowledge present in the textbook and how does it relate to SD?
- How do I identify SD -relevant information and how do I synthesize information? (For example, working with keywords or mind maps.)
- How do I represent information? (For example, the process for elaborating a map, a mind map, a poster, or a PowerPoint presentation.)

Two remarks are to be made concerning this table.

1. When working on the principle reflecting values, the aim is to make implicit values explicit, link them to one another and to a common reference related to SD (for example, the common guidelines of the *Earth Charter*). In the process, it is essential to distinguish different scales (looking at underlying economic logics explaining the way transport of goods is organized or looking at my individual transport choices) and different steps. When working at an individual level, personal values and their translation in space can differ greatly and should be acknowledged and given room as they are, without being judged. That means that if someone prefers living in an individual house in the countryside and someone else in an apartment in the city, the first step would be to make underlying values and needs explicit ('I like calm and the possibility to play in the fields' in the first case; 'I like meeting other people and being near to urban activities' in the other) without commenting on them.

A second step can put the formulated values into perspective, looking at the values of others and at pros and cons of each way of living at individual and collective level, as well as for the natural environment (what would it mean for me, for others and for the environment if everyone had a detached house/ everyone lived in apartment buildings?). A third or alternative step could be to take a further perspective and make an explicit link to the normative aspect of SD in comparing each way of living with globally accepted documents, such as the *Earth Charter*. Or to devise an exercise based on the availability of a resource: you have X square metres to lodge X people, what kind of lodging will you have to plan? (see comment on the second ESD-compatible existing example in section 3.2). On this basis, it would be possible in a fourth step to discuss alternative ways of

living and organizing space, taking into consideration the elements tackled. If working directly with learners' perspectives could be stigmatizing or not relevant, alternatives are to use 'external' pre-existing examples or to work at another scale.

In brief, working with the values underlying spatial organization is about working on these steps and not just about telling learners what is right or wrong. Vare and Scott (2007, pp. 193–194) acknowledge that prescriptive measures promoting 'behaviours and ways of thinking, where the need for this is clearly identified and agreed' (for example, recycling) might make sense on the short term. However, they add that the capacity to think critically on these same prescriptions and to 'test SD' ideas is essential in the longer term (for example, maybe it is more appropriate to produce less waste than to recycle, or recycling infrastructures might take away employment from poorer people who earn a living from recycling). In other words, although they see both approaches – the prescriptive and the reflexive – as complementary, they write that the 'future will depend less on our compliance in being trained to do the "right" thing now, and more on our capability to analyze, to question alternatives and negotiate our decisions' (p. 194).

2. Some suggestions present in the table lead to self-exploration by the learner, fieldwork and interaction with non-educational actors. Whereas these activities cannot be realized only by working with the textbook, the last is a central learning tool to facilitate instructions, work on methods and allow meaningful ways of institutionalizing the acquired knowledge, as suggested under acquiring knowledge. This, however, implies that the textbook cannot be used as a 'ready-made recipe' but requires the active role of the teacher, who is seen more as a learning coach than a knowledge transmitter.

## 2.2.3

## Example of creating geographical tasks along ESD principles for the topic of water

To illustrate how these pedagogical principles can be implemented within a geography textbook, an example based on the content developed previously for the topic of water will show how geographical tasks can be elaborated to contribute to ESD. The activity presented here requires that at least three examples of possible ways to shape the human-nature and human-human interrelation in a sustainable way have been worked on in the textbook previously. This will enable the learners to build on what they have done already. Possible learning outcomes are that the learners will be able to:

- **GIVE** one reason explaining why the initial situation can be considered unsustainable and why a change has to be undertaken.
- **EXPLAIN** the perspective of each implicated actor regarding change and identify one conflict of interest.
- **PRESENT** a possible alternative development and give two arguments explaining how it solves the problematic situation in the best possible way.
- **EXPLAIN** one impact this alternative has on
  - The river (an increase or decrease in pollution).
  - Two implicated actors.
  - The local spatial organization.
- **COMPARE** two possible alternative developments and evaluate which is more in coherence with the principles of SD, giving two related arguments.
- **DRAW** the spatial impact of the most sustainable solution.

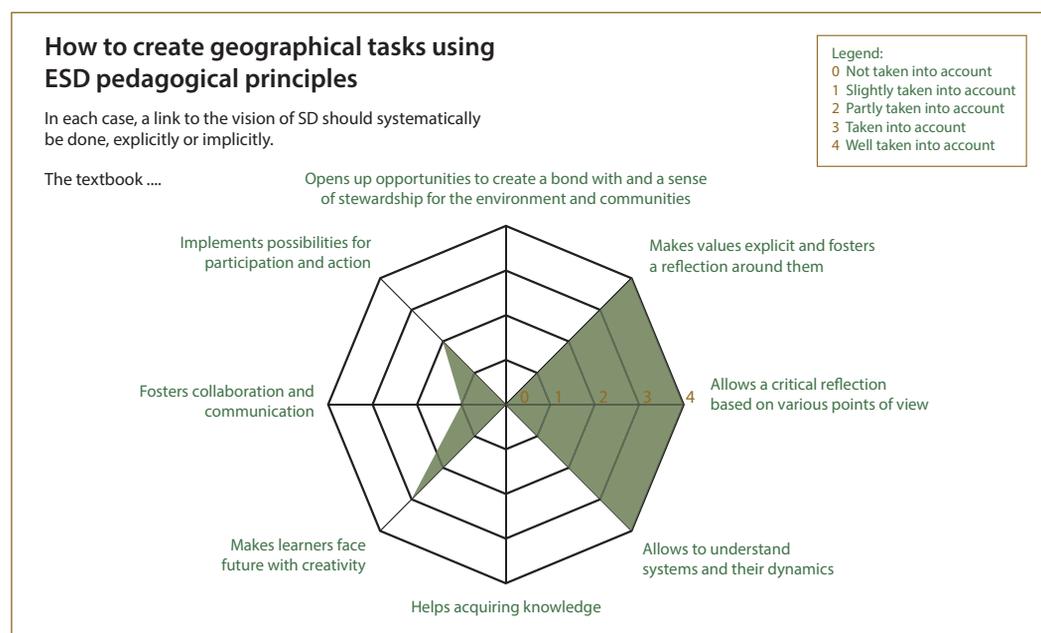
As a reminder, tasks in this example are based on the content of the previous ‘polluted river’ scenario as set out in section 2.1.2. on p. 120.

- **Situation (as text):** The factories on the river X use water for processing their goods, which are successfully sold for export, providing a strong financial income for the local communities. However, these factories are polluting the river to such a degree that its natural systems are breaking down, adversely affecting the health of all living things that depend on the river – humans included. A decision has to be taken on what to do: the situation cannot continue. The local governance system allows participation of civil society to a certain extent.
- **Actors’ perspective (in illustration and text):** Pictures of several actors are inserted in the textbook with related texts expressing their perspectives, their relationships with the river and their decision-making power. The factories are represented by economic actors, whose aim is to make money but whose businesses depend on the right to use the river, granted by the local government. They have a lot of power because they fostered the area’s economic development. The local government representatives depend on the industrial activity because it brings in tax money. They also have to ensure the health of their community and ecosystems, be it only to secure their re-election. They have the power to intervene through legal means by not renewing the right to use the river. The members of the local community are affected by pollution and fear for their health. But quite a significant amount of people are employed by the factories and some wealthy community members can afford and appreciate the products. The community is weak in terms of its power but can wield influence if its members gather together to exert pressure at a political level or if factory workers decide to strike.
- **Impact on space (as a map):** A schematic map of the area showing geophysical aspects, existing industrial infrastructures around the river and localization of the communities.

## Tasks

- Learners are asked to identify one argument for the status quo and one for a change per actor. In the textbook, a table with one line for each actor and two columns (pro and con arguments regarding change) helps to organize the information.
- In groups of two or four, the students are required to develop one idea for a possible alternative, taking into account the fact that the regeneration capacity of the river is overcome and there is a risk that further collapse of the ecosystem would be irreversible. They can refer to the previously seen example to elaborate the alternative, which they have to justify. In the textbook, a space is provided in which the learner can write down the imagined alternative and its justification.
- The elaborated alternatives and their justifications are presented to the class, the aim is to be as convincing as possible. The class votes on the suggestion they find most adequate and convincing. Underlying values affecting the vote are discussed.
  - A blank space is provided in the textbook in which to write down the result of the vote and the main related arguments.
  - In a list of possible underlying values present in the textbook, learners underline those relevant to their situation. This list has to prompt reflection of ecological sustainability and social justice but also contains unrelated values, such as the profit motive.
  - Using a coloured pen, learners mark whether the decision will make a positive (☺) or negative (☹) impact – or both – on each actor in the table they had previously filled.
  - On the map, they draw the implications of their decision on the way space is organized.
- Learners use the given documents to determine which actors have most power in decision-making and underline them in the table to answer the question: ‘Would the decision within the community have been the same as yours if you had taken existing power relationships into account?’ According to the answer, another colour can be used to see who is affected positively or negatively by the decision that has been taken (it is supposed that those in power will be affected positively), and what impact this would have on space.
- As a last step, the textbook provides a text presenting the alternative the community has found ‘in reality’ for the studied case and a related map showing the impact of the decision on space. Learners compare the solution they have imagined with the real one and are asked to evaluate which best respects ecological sustainability and social justice and why. The textbook leaves a blank space for learners to write down the answer and its justification. If the imagined situation is close to the real one, learners can simply explain in what ways it is sustainable.
- Space is left for a general concluding comment, such as: ‘To take into account the long-term sustainability of the affected communities, the preservation of the river and the health of the communities had to be set as a priority. Industrial activity was reduced so it was no longer affecting the ecosystem, while still generating some income. An alternative activity, not reliant on the river, had to be found for the people no longer employed by the factories.’

A spider-web corresponding to this example is as follows.



*Spider-web 2 completed:  
Shows the tool being used to evaluate how the imagined geographical tasks contribute to ESD*

### Completed Spider-web 2 shows how the following ESD principles are addressed in this exercise

- Dealing with systems has been tackled in the described situation itself (echoing the human-environment interrelations and the actor content criteria) and through the work around implicated actors and their power relationships. The dynamics of the system are illustrated when learners reflect on the implications of a change on parts of the system (positive/negative impact for each actor and on the river) and on the system as a whole (map of the alternative development).
- Critical thinking has been worked on by setting out the pros and cons of change and making visible the partly conflicting interests and power issues of different actors.
- A reflection around values is addressed by the fact that the underlying values of each actor and of the common vote are made explicit. The action of drawing a map shows the implication of a given choice and its underlying values on space.
- Room is left for facing the future with creativity because learners need to imagine alternative development possibilities, based on the information given in previous examples and for each actor. They then can link their deductions to the real situation.
- Participation is fostered through the need to find a common solution, the voting process and the examination of the consequence of a choice on space.
- Collaboration and communication are also addressed when the alternative solutions are discussed in groups. Communicating these solutions in a convincing way is part of the task.

### Ways to make interdisciplinary connections

- **Possible link to natural sciences** – chemical pollution of water, river ecosystems.
- **Possible link to language** – type of speech according to status in society, use of language for advocacy while presenting the imagined alternative solution (see Language chapter,), constructive negotiation.
- **Possible link to mathematics** – calculate coordinates for locating the industrial area, calculate the diffusion of pollution according to the water flow, determine statistics related to health issues.

#### 2.2.4

## Examples of tools that work along ESD principles within geographical education

There are many useful tools and methodologies to help integrate sustainability issues into geography textbooks. We present a very short selection of three to show how existing cross-curricular tools can be used within an embedding process in geography and how they can be articulated with the ESD pedagogical principles presented above. Some tools are optimal for working more specifically on one of the ESD pedagogical principles but often they can help foster several of them, depending upon how (in which 'pedagogical scenario') they are implemented. The origins of the presented tools are as following:

- The Sustainability Compass and the Pyramid Model of learning and planning for sustainable development were developed by the AtKisson Group and have been widely adopted in educational circles through the NGO Compass Education (<http://www.compasseducation.org>). They are available for free at <http://atkisson.com/acceleratorlite>.
- The Iceberg Model is a widespread system-thinking tool presented by Goodman (1997) and adapted for use in various fields since then: [http://www.appliedsystemsthinking.com/supporting\\_documents/Intro4WsandHow.pdf](http://www.appliedsystemsthinking.com/supporting_documents/Intro4WsandHow.pdf)

### **SUSTAINABILITY COMPASS** for exploring sustainability issues

The example used for water is shown here again to illustrate a way of using the Sustainability Compass. The tool takes the familiar direction points of North, East, South and West and gives them the labels Nature, Economy, Society and (personal) Well-Being. This helps to integrate the differing aspects of sustainability so the user can have a much more complete vision of the sustainability issues surrounding a particular topic. It works well for geography topics, bringing in a spatial dimension. The idea is that when educators and learners become better systems thinkers and better understand the interconnectedness of the human and natural systems all around them, their capacity to see areas where change can help to steer these systems toward sustainability increases.

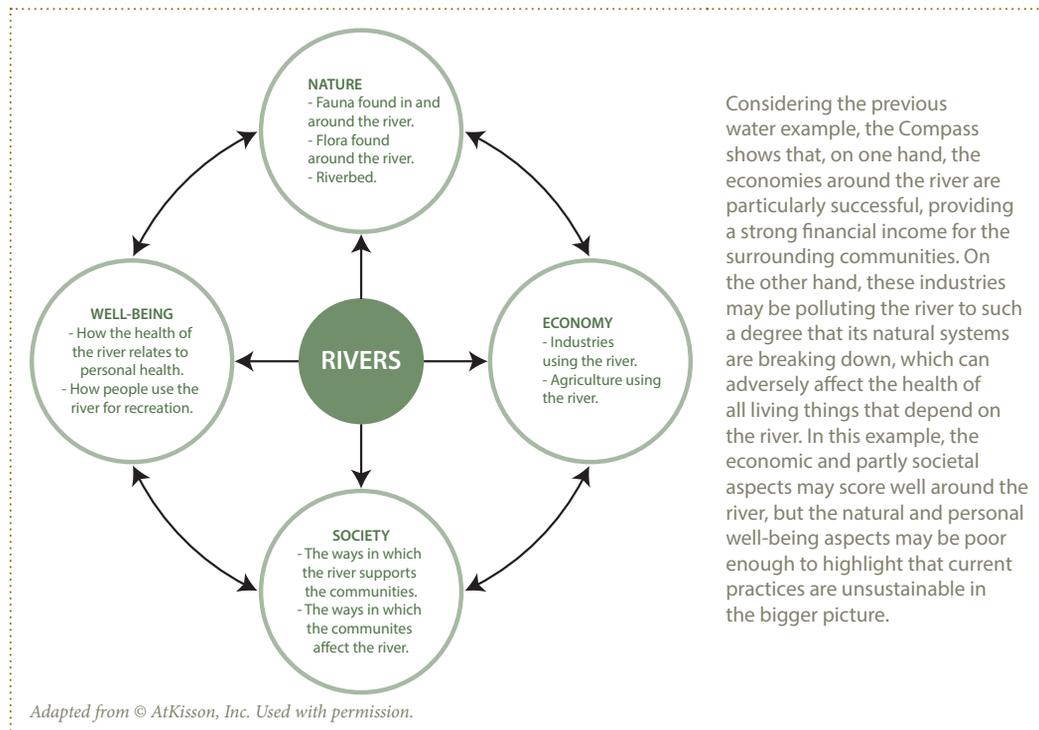


Figure 9: Sustainability Compass used for the topic of water with a focus on rivers

Textbook writers can use the Compass in three possible ways:

- **As a tool for themselves.** By placing a topic or issue in the middle of the Compass, textbook writers can look at ways to take each compass point into account. This can help for a detailed implementation of parts of the spider-webs (for example, human-environment interrelations for content and critical thinking or dealing with systems for principles). For example, when writing a unit about rivers, a writer can use the Compass to be sure he/she has provided the necessary information needed for seeing the big picture of how our human systems depend upon and affect rivers.
- **As a tool provided to educators in the teachers' guide, if any.** Teachers can use the Compass in their teaching in complementary ways to the textbook. They can use it for brainstorming with the class on an issue or to help planning their teaching unit.
- **As a tool provided to learners.** They can examine a topic or issue in much the same manner, or assess the sustainability of an issue. Putting the issue in the middle of the Compass allows learners to look for positive and negative ways in which the issue affects the sustainability of each compass point. They thus can then get an overall picture of the sustainability of the issue as a whole.



Source: Compass Education

### Link to the ESD pedagogical principles

This tool is ideal **for dealing with systems** and is one way of addressing the core geographical concept of **human-environment interrelations**, making the link between the individual and a broader context looked at from three perspectives. In doing so, it also fosters **critical thinking** as conflicting interests might emerge. If an exercise is added whereby learners need to think of possible scenarios if a component of the system changes, the idea of **facing the future with creativity** is also worked on. Eventually, the compass can also be considered as a method learners can integrate for the principle of **acquiring knowledge**.

## ICEBERG MODEL for exploring underlying causes

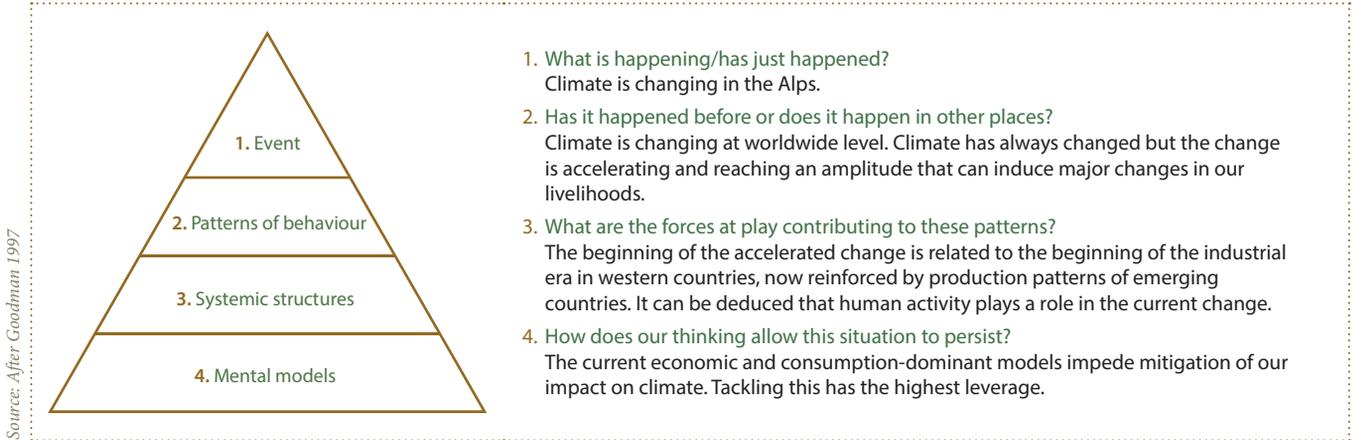
The Iceberg Model is a way of exploring the underlying causes of an event and corresponding driving values. By placing an event at the tip of the iceberg, you can work your way under the surface to identify the patterns of behaviour that led to the event. From there, you can dive deeper to understand the systemic structures that fostered those behavioural patterns. Finally, you reach the mental models of the society that laid the foundations for the event. The idea is that an intervention at the level of mental models has the most leverage.



Source: Compass Education

Figure 10: The Iceberg Model and how it can be applied to a geography that contributes to ESD

As with the Sustainability Compass, this model can be used for the textbook writer, the teacher or the learner.



### Link to the ESD pedagogical principles

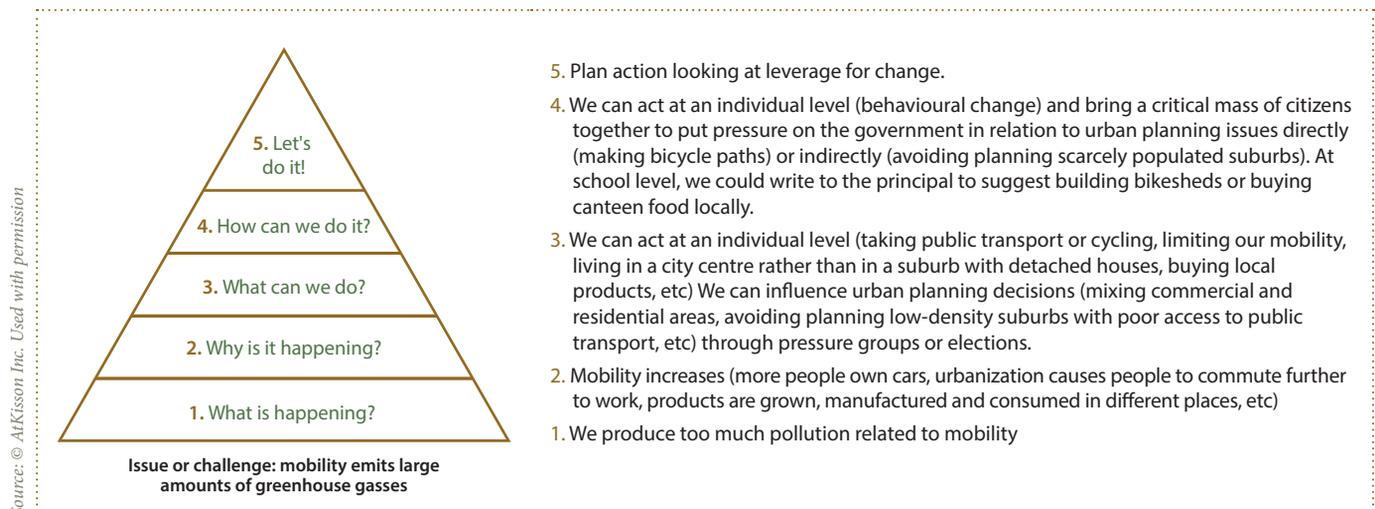
This tool is ideal for working around the principle of **reflecting around values**, **critical thinking** but also **dealing with systems**. In showing underlying driving forces, it might foster creative alternatives that look at the root of an issue. If an exercise is added whereby learners must think of possible scenarios if a component of the system changes, the idea of **facing the future with creativity** comes to play. And if the model can be used for further learning/exploring of the world, it can again contribute to the principle of **acquiring knowledge**.

Figure 11: The Pyramid Model and how it can be applied to a geography that contributes to ESD

## PYRAMID MODEL for exploring sustainability learning and action

The Pyramid Model is a way of looking for solutions to sustainability issues. We start at the bottom of the pyramid and look at what is happening, why it is happening, what we can do and how we can do it.

As with the Sustainability Compass, this model can be used by the textbook writer, teacher or learner.



### Link to the ESD pedagogical principles

This tool is ideal for working on **facing the future with creativity** and **participation**, helping to link global issues with local actions (thus **tackling scales**). It requires a good understanding of a present situation, thus mobilizing **critical thinking**, **dealing with systems** and **reflecting around values**. And again, according to how it is used, a contribution to **acquiring knowledge** can be seen.

Other resources provide more tools to help embed ESD in geography textbooks. These include:

- *The Part and the Whole* from the Swedish International Center for Education for Sustainable Development suggests ready-made activities for embedding ESD in geography, emphasizing the idea of (global) public good: [http://lun.gu.se/digitalAssets/1451/1451398\\_the-parts-and-the-whole.-worksheets.pdf](http://lun.gu.se/digitalAssets/1451/1451398_the-parts-and-the-whole.-worksheets.pdf)
- *Geography: the Global Dimension* from the English Development Education Association presents several tools in the field of global citizenship education. These include a Multiple Identities Map, which makes our link to diverse spatial scales visible, and a Future Frame, which works on scenarios for the future: [https://think-global.org.uk/wp-content/uploads/dea/documents/dea\\_geography\\_gd.pdf](https://think-global.org.uk/wp-content/uploads/dea/documents/dea_geography_gd.pdf)
- John Morgan's book *Teaching Secondary Geography as if the Planet Matters* (2012) provides many ideas in the field of critical geography on topics such as climate change, cities and food.

## 3.0

# Examples of embedding in geography textbooks

The natural hazards topic has been used to show what type of geographical content can contribute to ESD (see section 1.2.1). A complete example around the water topic has been elaborated to show how to use the spider-webs for embedding ESD. This section presents further examples of ways to embed ESD in geography textbooks.

- A first one shows how both spider-webs can be used, in this case for a topic related to urban planning designed for very young children. This implies that a teacher's guide is available: most of the information is aimed at teachers because their pupils are not advanced in reading and writing.
- Further examples show how the spider-webs can be used for analyzing existing material and developing it towards ESD:
  - Five examples are extracted from textbooks that already address embedding to a certain extent. A comment shows how this can be taken further. The topics tackled are: vital and secondary needs and their impact on spatial organization; urban planning; mobility; agriculture; environmental conflicts.
  - A last example shows how embedding can begin with a resource book's existing content and then be completed with geographical tasks following the ESD pedagogical principles. The topic is desertification.

Aside from the first example, the pragmatic focus on existing material aims to:

- Demonstrate that some existing material already embeds elements of ESD and can be used as inspiration
- Show that embedding ESD does not necessarily mean starting from scratch but that existing material can be used as an entry point.
- Make explicit the articulation between existing practices and possible further embedding.

## 3.1

**EMBEDDING EXAMPLE****Daily geographies for young children**

Exploring the places of our ‘daily geographies’ (home classrooms, gardens, school buildings, etc) is a possible first step of geographical education. The spaces where we carry on our daily lives are the ideal context for working on the basic spatial patterns defining our private and social geographies. They help us to understand the relation between places and their functions and to get in touch with the interrelations between the different actors who share these spaces. Exploring daily places can be considered preliminary ‘geographical work’. Moreover, school buildings are social spaces, they work through synergies and interrelations between humans and natural environments. Understanding the balance and negotiations underlying these synergies and interrelations deals with the values and meaning of sustainability. This example shows how such elements can be integrated within a related chapter, looking at content first and then at a corresponding set of tasks.

*Exploring daily places can be considered preliminary ‘geographical work’. School buildings are social spaces, they work through synergies and interrelations between humans and natural environments*

**Selecting content for the theme of daily geographies – chapter level (pre-primary)**

**Core question:** Is our school people- and nature-friendly or can we make it so?

**Sub-questions:** Who is in our school and how is this reflected in space? Is our school welcoming to everyone? Is our school nature-friendly?

**Localization: where and why there?**

Looking at where the school is located in a district and understanding why it is located there is a first step towards ‘thinking geographically’ (see also next sub-section: ‘which human-environment interrelations?’). At another scale, the relevance of the location of each place inside the school building can be addressed: the classrooms, the corridors, the access points. Furthermore, it helps to consider the role played by two spatial categories: distance and accessibility (see also ‘patterns and processes’). What are the advantages of being located next to the corridor or to the playground? We gain time. We do not have to cross all the building to get to the playground. We have more time for outdoor activities. Or why isn’t the playground next to the carpark? Because it might be dangerous (security and pollution). This kind of reflection is an introduction to the relationship between places and their functions.

*Contribution to ESD: ESD is about starting from our own daily experiences. Geography can contribute to this by stressing the importance of understanding our private and social experience in daily life and how crucial space is in influencing this. It is also a base from which to start reflecting on how space organization can be more or less inclusive and sustainable.*

**Which human-environment interrelations?**

To analyze the physical environment of the school or to work on the bond children might feel with the natural elements of their surroundings (a tree, a bird, the view of the lake, etc) can be a way to start addressing these interrelations. Where is the school located (on a hill, on flat land, near a river)? What implication does that have (we only have a short walk to school because it is in the city near our homes but our playground might have been bigger if we were in the countryside). Alternatively, to stay at school scale: what was done to let the sunlight in? Is there a place that is windier? Is there any green space in the playground?

*Contribution to ESD: Looking at the way we organize space in relation to our natural surroundings allows us to introduce a core aspect of ESD – showing things as a system. Geography specifically illustrates these interrelations in space by stressing the link between places, functions and rules, and their relation to the natural environment.*

**Which human-human interrelations, which actors?**

In exploring daily places, pupils deal with some very relevant spatial queries. Are we the only users? With whom do we interact? Does everybody use the school the same way? Who decides if something has to be modified in the school building? Schools are, essentially, social spaces and studying them ‘as geographers’ means understanding the human-human relations affecting the private and collective activities we carry out within these spaces.

*Contribution to ESD: Becoming aware that space is shared by various actors and reflects their needs requires us to overcome an egocentric approach to our daily places and to negotiate with others possible uses of space. Geographical education studies these dynamics in space and so brings an important perspective on the idea of needs, equity and sustainability.*

### At what scales?

It is possible from an early stage on to work on different spatial scales and their interaction. Children are able to understand that their table (private space) is part of a classroom (familiar collective space), which is part of the school (larger collective space), itself part of a district. Depending on which scale you are considering, the geographical considerations can vary significantly and a same issue might have different impacts at these scales. Why is our classroom nicely decorated but the corridor is not? Because we do not have the same sense of ownership of the corridor, which is shared by more people, some of whom we don't even know. Or because we didn't know we could decorate the corridor.

*Contribution to ESD: Empowering our private sense of place at a local level can contribute to ESD because it makes us feel responsible for a given place, which is the first step towards responsibility. From there, becoming aware of scales and their interrelations (my table, my classroom, my school) is a further step linking local to wider scales, which is central to ESD. Moreover, looking at common spaces (for example, the playground) and working on a sense of ownership of them encourages us to reflect on what is defined as 'common'. This can be scaled up to worldwide common goods (for example, our atmosphere), thus contributing to ESD.*

*Looking at patterns and processes helps us to understand SD issues and look at possible alternative evolutions*

### What dynamic (patterns and processes)?

Understanding the role of accessibility and distance in using daily spaces is the first step to introducing the idea of geography as the study of structures and recurrent logics within space. The spatial organization of the school building illustrates how the function of each place relates to a set of basic geographical patterns: each classroom is structured in a similar way, except for the decoration, and there is a principal's office in each school. Over the years, many playgrounds in urban areas have become smaller as a result of school buildings increasing in size to accommodate larger numbers of children.

*Contribution to ESD: Recognizing geographical patterns helps us to understand 'the big picture' and leads to a level of generalization allowing for comparisons. The process aspect is crucial – keep in mind that spatial organization is context-bound (in time and space) and might evolve to become more or less sustainable. Looking at patterns and processes helps us to understand SD issues and look at possible alternative evolutions.*

### Example of possible tasks within this subject (pre-primary school)

A possible set of tasks within this chapter would be to identify who is using the school (actors), what their role and activities are and what spaces they use. Based on this, work would take place around issues of well-being and integrative equity, always linking the questioning to spatial issues. A last step would be to make the link between the way school is spatially organized and ways of connecting to natural elements. This set of tasks is presented on the two next pages and is articulated around the following ESD-related pedagogical principles:

- **Bonding and stewardship.** To discover a place from a new perspective and to reflect possible reorganizations of this space enhances the sense of ownership and familiarity.
- **Dealing with systems.** Learners become conscious that school is a social space with human interrelations, built in an environment that has natural components.
- **Facing the future with creativity.** Learners have to imagine a solution for making the school more inclusive and more prone to welcoming natural elements.
- **Collaboration and communication.** As each group of learners has to identify one actor and its related use of space, the final product depends on the work of everyone. The visualization suggested starts working on ways to represent gathered data.
- **Participation.** In getting to know the roles of different actors in the school, it is easier for learners to imagine who has to be addressed if they want to implement change. According to the school and the solutions suggested by learners, it might even trigger a change for real.
- **Acquiring knowledge.** By making an inquiry, learners start to become acquainted with investigation tools and ways to represent results. The tools we use, queries we make and activities we undertake in small places are the same ones we need to tackle neighbourhoods, parks, villages or urban areas.

## TEACHER'S PART

### Suggestion for a learning situation

## Who is in our school and how is this reflected in the space?

#### Notes

Children at this age are still learning to read and write, so the textbook mostly gives instructions to teachers, as shown here.

#### Learning objectives – the learner is able to:

- Name at least three actors in the school and explain what their role is, one related activity they carry out and one way in which they use space accordingly.
- Explain two ways of possible spatial reorganization within the school that favour social and ecological inclusiveness.

**MODALITY:** Collaborative group work for step 1 (for example, groups of three learners do the inquiry for one actor), individual for step 2.

**CORE QUESTION:** Is our school people- and nature-friendly or can we make it so?

#### STEP 1

#### INQUIRY

**Inquiry into actors, their activities and tools and how they use space.**

#### Possible way of introducing the subject

*'OK class, do we think we really know our school? Do we know it like a group of geographers would? Do we know who is in our school, what they do and in what kind of rooms they are?'*

The teacher can start filling in the 'school' (see picture) with what learners already know, or think they know. The aim then will be to verify what has been suggested and complete what is not known by making an inquiry that will identify:

- Who is in the school => picture.
- What their name is => writing.
- What their role is (teacher, principal, school nurse...) => writing.
- What activities are related to this work => writing and/or drawing.
- In what places they work and how these places are organized => picture.

The 'school' is filled with the gathered data (some parts can be written by the teacher if there is too much to be written by learners of that age), with corrections made where the learners' initial suggestions were not adequate.

#### A discussion takes place along the lines of the following questions:

*What can you observe?* => For example, not everyone uses space in the same way, it depends on your role and your activities.

*Do you feel at ease in the space you use or would you rather be in one of the other identified spaces? Why?* => For example, some children would like to have the opportunity to go to a quiet corner for

reading because there is too much noise in class and it is difficult to concentrate. You can then ask if this could be implemented => For example, one quiet corner could be implemented, but not one for each child.

When this is done, the 'school' can be kept in class or a picture of the result can be taken, printed and distributed to the learners. A concluding sentence based on the observations is written down as a conclusion for this step, such as: 'Not everyone uses the school in the same way, it depends on your role and your activities. It is important to organise the school so that everybody can work and study in it. This is also true for other places.'

#### Possible results of the inquiry

Who?	Name	Role	Activities	Places & organization
	...	teacher	...	
	...	principal	...	
	...	school nurse	...	
	JAYBA	librarian	...	
	AYME	cleaner	...	
	FAKINE	gardener	...	
	WILMA	security guard	...	
	PERFO	student	...	
	DORINGA	student	...	

Remark: If no camera is available, photos can easily be replaced by drawings.

**STEP 2**

**INCLUSIVENESS**

Based on the inquiry made in step 1, discuss the two following points:

1. Does everybody have a space in which to work or is someone excluded?
2. Could people with disabilities work or study in our school?

Introduce the worksheet ‘*Is our school welcoming to everyone?*’ and discuss possible answers to the first question before letting the children write

them down. The other questions can be solved individually and then discussed together, based on what children have written/drawn.

A concluding sentence could be: ‘*The way a place is organised can be more or less inclusive.*’

**STEP 3**

**THE RELATION TO NATURE**

A discussion takes place around what elements of the natural environment learners like in or around the school and why they like them. On the worksheet ‘*Is our school nature-friendly?*’, learners draw one of these elements. In a second step, learners choose from elements presented on the worksheet and imagine where within the school

area they could be implemented (in the courtyard or in a quiet place just behind the school?) A map of the school has to be provided by teachers.

A concluding sentence could be: ‘*Natural elements are part of the places I live in and influence my way of living in them.*’

**STEP 4**

**CONCLUSION**

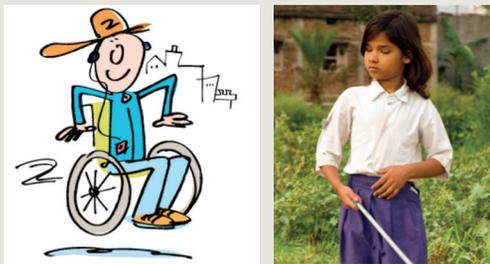
A concluding sentence can be written down to answer the initial question: ‘*Is our school people- and nature-friendly or can we make it so?*’

An example of a possible concluding paragraph would be: ‘*Our school welcomes many different people who have different needs and use space*

*accordingly. It also has some natural elements. It is people- and nature-friendly but could be more so. Possible measures would be to have wheelchair access at the main entrance and to set up a small garden in the playground. We would have to ask permission from the principal and would need the help of teachers in implementing that.*’

**STUDENT’S PART**

**Is our school welcoming to everyone ?**



Would these two children have access to our school?

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If not, what could we do to make the situation better? Write or draw a possible solution.

---



---

With whom would you discuss your idea if you wanted to implement the measure you describe?

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**Is our school nature-friendly?**

1. Draw one natural element present in your school or its near surroundings that you like.

2. Among the natural elements pictured below, choose one that you would like to see in your school, explain why you would choose it and show where in the school you would put it. If you have another idea, write it down or draw it in the empty box!

**Prairie with wild flowers**  
*(adapt to context)*

**Beehive**  
*(adapt to context)*

**Bird house**  
*(adapt to context)*

*Schematic map of the school (to be glued in). If one does not exist, it can be roughly drawn by the teacher, copied and glued in or drawn by the students.*

**School garden**

**Void box for learner’s idea**

**I chose this because ...**

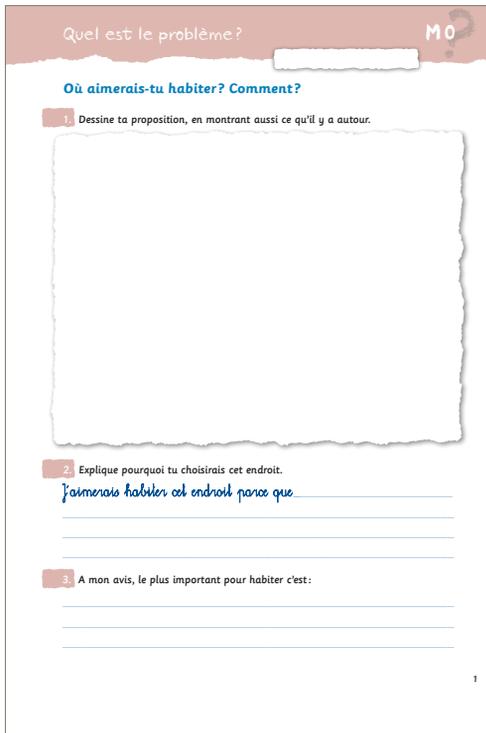
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Sources of the pictures (consulted on 9.1.2017): Boy in wheelchair <http://tpe-smc-handicap.e-monsite.com/pages/c-l-integration-dans-le-milieu-scolaire-et-professionnel.html> Blind girl <https://www.pri.org/stories/2014-08-07/how-do-you-make-walking-easier-people-who-are-blind-put-submarine-tech-cane>

3.2

## Turning existing ESD-compatible examples into ESD examples

### 1<sup>st</sup> ESD-compatible existing example (primary school)



Source: Habiter. Fiches élèves. CIIP (2013)

The following examples are extracted from a chapter on 'housing and living' from a recent textbook that has integrated elements of ESD. The first activity is an introductory exercise composed of the following steps (see French version alongside<sup>7</sup>). Learners are requested to:

1. Draw their dream 'place to live' (where would you like to live and how?) in the blank space.
2. Explain why they would like to live in that place.
3. Say what is most important to them about living in that place.

#### Analysis

This worksheet aims to integrate the learner's perspective, showing what is important to them about housing (for example, one child might draw a detached house with a big garden and a fence around it, while another might draw an apartment with many children playing together in a communal area). This will allow a link to be made between this perspective and various aspects of the topic tackled later on. Therefore, no content is worked on here. At the level of pedagogical principles, looking at the different drawings enables learners to reflect on values associated with what is considered 'good' housing and how that affects space. Moreover, pointing out that not everybody considers the same things important introduces elements of critical thinking.

**Note**

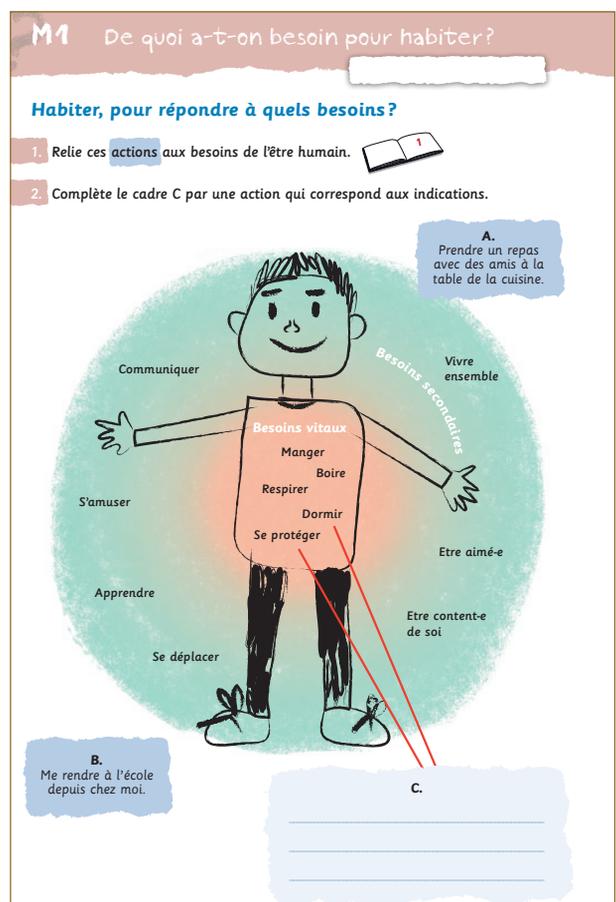
This kind of worksheet with many blank spaces can be replaced by an instruction in the textbook – the drawing can be made on a separate sheet or in the learner's workbook.

The next activity focuses on the distinction between vital needs (at the centre of the person) and secondary needs (around the person) and how they relate to space.

**STEP 1**

The learner has to draw lines between a situation and its corresponding needs (for example, 'have a meal with friends in the kitchen' would be linked to 'eat' as a vital need and 'socialize' as a secondary need) or find out a situation from given needs (protection and sleep as vital needs => 'have a bedroom').

A discussion takes place on the difference between vital needs and secondary needs and the sometimes blurred boundary between both (according to the situation, running away becomes vital). It is observed that everybody has vital needs but that secondary needs can be given different priorities. A link to the former worksheet can be made, looking to what needs the 'dream house' addresses.



Source: Habiter. Fiches élèves, CIIP (2013) p.2

<sup>7</sup> Extracts of the textbook have been provided although in French so as to give an idea of the layout. All contents and tasks are explained in English in the text. In one case, a worksheet has been translated so as to give a clear idea of how things are structured.

**STEP 2**

The link to the United Nations' Convention on the Rights of the Child is made, showing that some of these needs have been translated into rights. Having a shelter is one of them.

**M1 De quoi a-t-on besoin pour habiter?**

**Les dix principaux droits de l'enfant**

- Art. 1 Le droit d'être protégé-e contre toute forme de discrimination en raison de sa race, de sa religion, de son origine ou de son sexe.
- Art. 2 Le droit d'avoir un nom et une nationalité.
- Art. 3 Le droit à la santé.
- Art. 4 Le droit de recevoir une éducation et une formation.
- Art. 5 Le droit d'avoir des loisirs pour jouer et se reposer.
- Art. 6 Le droit de s'informer, d'exprimer son opinion, de voir celle-ci prise en considération et le droit de se réunir.
- Art. 7 Le droit à une sphère privée et à une éducation imprégnée d'un esprit d'égalité et de paix.
- Art. 8 Le droit de bénéficier d'une aide immédiate en cas d'urgence et celui d'être protégé-e contre toute forme de maltraitance.
- Art. 9 Le droit à une communauté de type familial, à la protection de parents et à un toit sûr.
- Art. 10 Le droit de recevoir des soins spécifiques en cas de handicap.

Source «Convention des droits de l'enfant», UNESCO, 1989.

Source: Habiter. Cahier élèves, CIIP (2013) p. 2

**STEP 3**

Needs are linked to rooms in a house. Conclusions: different places in the house address different needs and so have different functions. Housing meets numerous needs. In some situations however, there is very little space and the same place meets nearly all needs.

**De quoi a-t-on besoin pour habiter? M1**

**Dans nos logements, où réalise-t-on ces actions?**

1. Inscris les numéros dans les pièces correspondantes.

- 1 Dormir
- 2 Se laver
- 3 Préparer un repas
- 4 Regarder la télévision
- 5 Lire une bande dessinée
- 6 Jouer avec des amis
- 7 Téléphoner
- 8 Aller à la place de jeux

**Nos constats**

Source: Habiter. Fiches élèves, CIIP (2013) p. 3

**STEP 4**

Through different graphs, parallels are made with national data (for a western country): the increasing need for space per person, the proportion of different kinds of housing and the different ways of using space (for housing, transport, work and leisure).

**De quoi a-t-on besoin pour habiter? M1**

**En Suisse, pour répondre au besoin de se loger**

Il y a de plus en plus de logements, de plus en plus grands:

- La population augmente.
 

Année	Population (millions)
1900	~1
1925	~2
1955	~3
1965	~4
1995	~7
2011	~8
- Les gens recherchent des logements plus grands.
 

Année	Surface de logement par habitant* (m²)
1980	34
2010	44
- Les ménages sont de plus en plus petits.
 

Année	Nombre de personnes*
1900	entre 4 et 5
2010	entre 2 et 3

\* en moyenne

**Logements selon le type d'habitation**

Type d'habitation	Proportion
Maison individuelle	56%
Commerce	21%
Immeuble	23%

**Utilisation de l'espace construit**

Utilisation	Proportion
Habiter	50%
Se déplacer	25%
Travailler	15%
Se détendre	10%

Source pour toutes les données: Office fédéral de la statistique (2009-2011)

Source: Habiter. Cahier élèves, CIIP (2013) p. 3

**Analysis**

At the level of content, this extract focuses mainly on actors, their needs, perspectives and values, and how these relate to space. Patterns and processes are looked at when addressing the national evolution of needs related to housing, which also allows a change in scales. Aspects of localization are also tackled

*Reflecting on the difference between vital and secondary needs, their impacts on space and the values underlying secondary needs is a core contribution to ESD, dealing with the basic needs of present and future generations*

when looking at which part of the house corresponds to which need. At the level of pedagogical principles, reflecting around values is clearly worked on as secondary needs can be seen to be more or less important to each individual. Here again, critical thinking is also tackled as underlying needs are looked at in space.

### Contribution to ESD and further possible steps for embedding

Reflecting on the difference between vital and secondary needs, their impacts on space and the values underlying secondary needs is a core contribution to ESD, dealing with the basic needs of present and future generations. The parallel to existing norms is also crucial, introducing a link between individual and collective needs, and between the idea of needs and rights.

Further possibilities for embedding would be to set a focus on spatial scales and human-environment interrelations. This would add elements related to global citizenship and peace, while addressing potentially conflicting interests between individual needs and ecological issues:

- Add pictures and maps of the houses of children from other parts of the world. Ask learners to reflect on whether basic needs are being addressed in all the illustrations and what kind of secondary needs can be identified. Compare them with those identified in the drawings made by the class in the introductory activity.
- Add a picture of two to three animals in their habitat and mention some needs they have.
- Introduce a reflection on concurring uses of space under the perspective of vital and secondary needs. For example:
  - Would you keep a swimming pool in your garden (secondary need) if you knew that a child down the street had no house (primary need)?
  - Would you rather have a big garden or leave some forest for the foxes?

The aim is not to moralize but to reflect the tension between vital and secondary needs concurring in space. 'In-between' alternatives can be discussed. For example, if all the children in the area have access to the swimming pool, is keeping it more justified, if having access to leisure pursuits is one of the children's rights?

## 2<sup>nd</sup> ESD-compatible existing example (primary school)

Vignettes à découper pour 26

M5

**MAISON INDIVIDUELLE**  
1 logement  
1 ou 2 étages  
1 à 5 habitants  
1 villa sur 1 parcelle  
(= 1000 mètres carrés)

**MAISON CONTIGÜE**  
3 logements  
2 étages  
3 à 15 habitants  
1 villa sur 1 parcelle  
(= 1000 mètres carrés)

**PETIT IMMEUBLE**  
12 logements  
4 étages  
12 à 50 habitants  
1 immeuble sur 2 parcelles  
(= 2000 mètres carrés)

**PETIT IMMEUBLE**  
12 logements  
4 étages  
12 à 50 habitants  
1 immeuble sur 2 parcelles  
(= 2000 mètres carrés)

**GRAND IMMEUBLE**  
80 logements  
8 étages  
80 à 300 habitants  
1 immeuble sur 5 parcelles  
(= 5000 mètres carrés)

Source: Habiter. Fiches élèves. CIIP (2013) p. 85

85

This part of the chapter addresses the issue that space is not unlimited. This implies that we need to reflect on how space is used: should we leave it to nature, use it for agriculture, for an industry or a shop, for parking, a soccer field, for housing? This exercise looks at different ways of using space for housing.

As a first step, learners have to cut out pictures of different types of houses (see image on left) and design a new 'ideal' residential district, sticking the houses on the void pieces of land, according to their own choices (see image on next page). Each dwelling type has information about the number of inhabitants it can house as well as the space required to build it (one or more 'squares'). Learners are also asked to draw some types of infrastructure (roads, leisure venues, shops) but the choice is left open. When done, learners count the number of people who can live in their district. They compare their district with those made by others to identify the scenario that can house the most people and the one that can house the least,

**M5** Comment habiter ici?

**Comment construire un quartier idéal sur ce terrain?**

Construis un nouveau quartier d'habitations sur ce terrain composé de 10 parcelles.

Respecte le nombre de parcelles exigé par chaque type de bâtiment.

1 Choisis des bâtiments et place-les de façon à réaliser un quartier idéal.

2 Dessine quelques aménagements complémentaires que tu estimes importants.

26

Source: Habiter. Fiches élèves, CIIP (2013) p. 26

looking at the type of houses built. They are also required to compare their district with those given in the textbook (see the image below) and to discuss the notion of density. In the last step, learners reflect on the pros and cons of three scenarios with different densities from the point of view of various inhabitants. Here, a link can be made to the original 'ideal house' the learners have drawn: should it be situated in a densely populated area or not?

**Analysis**

At the level of content, this extract focuses again mainly on actors and their various ways of shaping a district according to their worldviews. The main idea is to introduce the idea of density in a given space that can be planned in various ways. At the level of pedagogical principles, looking at various perspectives of 'planners' and the related impact on space can open up towards a reflection around values (preference for individual or collective ways of living together, space left for green areas, importance of leisure infrastructures) and critical thinking. But the idea of planning a district also addresses facing the future with creativity.

**M5** Comment habiter ici?

**Construire plus ou moins de logements sur un même terrain**

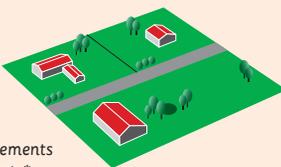
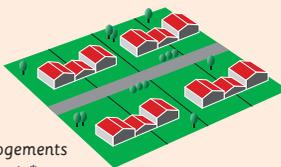
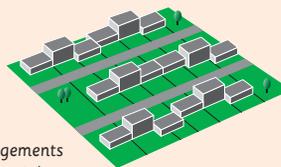
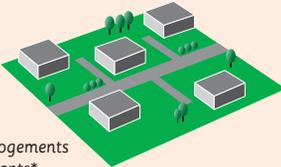
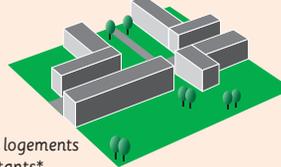
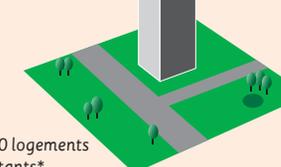
Que veut-on faire sur ce terrain?  
 - Le laisser comme espace naturel? Le cultiver?  
 - Bâtir une usine, un commerce, un hôpital?  
 - Réaliser une route, un parking?  
 - Aménager un parc, une patinoire?  
 - Construire des logements?

...ou combiner ces utilisations?

Construire des bâtiments d'habitation occupe un certain espace qui a de la valeur.  
 Un terrain coûtera plus cher s'il est grand, s'il est bien situé pour différentes utilisations, s'il est relié aux réseaux d'eau, etc.  
 Le nombre de terrains bien placés n'est pas infini: notre espace est limité!

Voici quelques exemples d'aménagement pour un terrain mesurant 100 mètres par 100 mètres (un peu plus grand qu'un terrain de football).  
**Combien d'habitants peuvent-ils être logés?**

\*en moyenne

<p><b>1</b> Dans des maisons individuelles</p>  <p>6 à 8 logements 15 habitants*</p>	<p><b>2</b> Dans des maisons jumelées</p>  <p>8 à 10 logements 20 habitants*</p>	<p><b>3</b> Dans des maisons contiguës</p>  <p>10 à 50 logements 100 habitants*</p>
<p><b>4</b> Dans de petits immeubles</p>  <p>40 à 80 logements 160 habitants*</p>	<p><b>5</b> Dans de grands immeubles</p>  <p>150 à 200 logements 400 habitants*</p>	<p><b>6</b> Dans une tour</p>  <p>200 à 300 logements 600 habitants*</p>

15

Source: Habiter. Cahier-élèves, CIIP (2013) p. 15

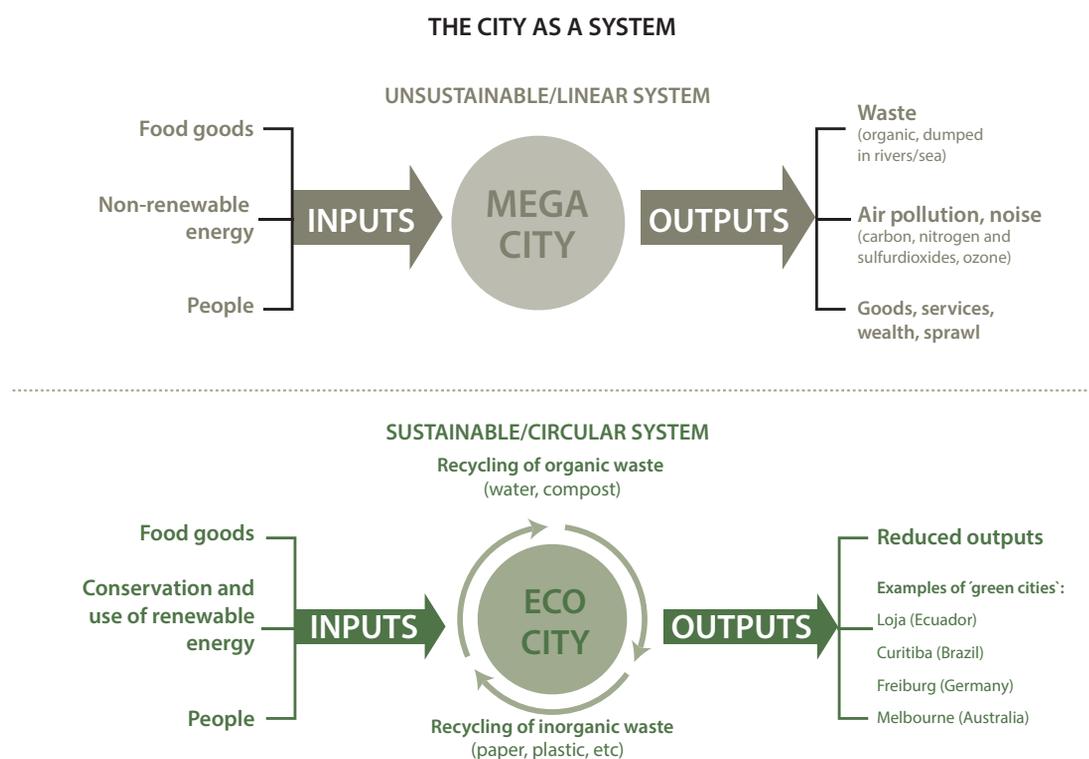
### Contribution to ESD and further possible steps for embedding

Considering the limits of a given space and reflecting on the best ways to plan it is of great interest to ESD. The subject can lead to reflection on the carrying capacity of our planet. To go into more in depth, it would be of interest to focus more on the human-nature interrelations. For example:

*Considering the limits of a given space and reflecting on the best ways to plan it is of great interest to ESD. The subject can lead to reflection on the carrying capacity of our planet*

- Ask learners to find a way to lodge the maximum number of people in this district so as to be able to leave other spaces undeveloped. This must be done without affecting the carrying capacity of the area regarding water supply and waste management. This means there is only a certain quantity of water available to support a limited amount of people without depleting the resource, and only a certain capacity to process the waste of a limited amount of people without damaging the environment. Learners can choose between two limits, one with a cautious use of resources (limit set at X persons if there is a conservative use of water and little waste is produced) and one with an unconscious use of resources (limit set at Y if water is used as if it were unlimited and lots of waste is produced).
- Show images of four different climatic environments. Ask learners to consider if the same density makes sense everywhere, considering the diversity of environments (the carrying capacity differs from one place to another).
- Require learners to empty two 'squares' of their former plan to foster urban biodiversity or leave an area unpaved to enable the ground water to regenerate. The learners will have to decide which infrastructures to 'sacrifice' and to consider the implications this will have for their district.

For older learners, it would be interesting to think of ways of using resources in a city and how this affects space. An illustration like the one below could be studied and the learners asked to think of two planning measures that could favour a circular system.



Source: Rogers, *Cities for a Small Planet* (1997)

Examples of possible measures would be to:

- Include marketplaces to enable the city's inhabitants to buy unpackaged local food, thus reducing waste and reliance on transport related to imported goods.
- Have a local waste incineration system or a local organic-based methane production infrastructure to produce electricity from waste.
- Cluster industrial activities together so the heat produced by one industrial unit can be used by another.
- Create a mix of housing, work and leisure opportunities to reduce the distance between them and thus reduce the use of fossil fuels related to transport.

The textbook can include examples of such cities, which have been analyzed from this perspective as a previous step.

### 3rd ESD-compatible existing example (upper primary school)

This exercise is embedded in a chapter on mobility. It looks at the reasons (work, leisure) for mobility and its impacts (resource consumption, costs, pollution but also increased accessibility to some regions, increased economic activity). It describes plans to build a new road to enhance traffic fluidity and avoid vehicles driving through a village. The impacts of this new road on various actors are examined through speech bubbles. They range from positive impacts (economic development, increase in tourism, decreased noise in the village, increased security in the village, increased accessibility of work) to negative ones (noise for nearby houses, impact on local ecosystems, impact on landscape, loss of good arable land, loss of economic activities in the village). In a first step, learners are asked to categorize actors (road user or resident of the area who does not use the road) so as to realize that a road also affects the people who do not use it.



Source: Mon canton, un espace... pour se déplacer, s'approvisionner et se divertir. Livre de l'élève, CIIP (2014) p. 34

**M3** FE\_EM3-3 **Mobility: what consequences?**

**A new road: why and for whom ?**

1. Using the documents in your book and the inquiry you made, fill the following table checking the boxes you think relevant and completing with the opinion of two interviewed persons

Testimony of:	The person sees...		The person speaks...	
	Advantages	Inconveniences	... for herself	... for a group
Luc				
Aline				
Alex				
Jean-Marc				
Claude				
Philippe				
Interview 1				
Interview 2				

2. If the new road would be built nearby your home, you would also be affected. What would your opinion be?

Your opinion:  In favour  Against

Give an argument: \_\_\_\_\_

I speak for myself (individual interest)  I speak for a group (collective interest)

What I have learnt/synthesis

---

Source: Mon espace, mon canton. Fiches de l'élève, p.34, CIIP (2014)

In a second step, learners are required to identify advantages and disadvantages of building a road, looking at each actor and deciding if they speak for themselves or a wider group. If a new road is planned in the area of the school, it is possible to complete the worksheet with the results of interviews made in the local community (see the last two rows of the table, left).

The learners are then required to take a stand, giving one argument and stating if it is an individual or collective viewpoint. A space is left for a synthesis, which could be 'Building a new road has pros and cons, depending upon the perspective of the actor and the impact on environment.'

#### Analysis

At the level of content, this extract focuses mainly on the impact of a spatial action on actors, looking at the multiplicity of perspectives and reflecting the tension between collective and individual interest. An opening is made towards the human-environment interrelation by evoking the impact on ecosystems and landscape. At the level of pedagogical principles, looking at possible consequences of a spatial action has elements of dealing with systems. The multiplicity of perspectives as well as an individual positioning helps to address critical thinking.

### Contribution to ESD and further possible steps for embedding

This example contributes to ESD by looking at a variety of impacts the construction of a road can have and the tension between individual and collective interest, thus working on social scales. The fact that the learner has to give their opinion within these multiple perspectives fits well with the idea of critical thinking and participation at the core of ESD. However, ESD could be embedded even further by integrating elements relating to human-environment interrelations, spatial scales and patterns and processes. By focusing more on critical thinking, dealing with systems and facing the future with creativity, it questions the root of the problem in a way more in coherence with sustainable development and, to a certain extent, global citizenship (see Figure 11: the Pyramid Model).

- Within the same exercise, two ‘speech bubbles’ could be added. One could mention the fact that building new roads often increases traffic, therefore solving the problem only in the short term. The other could state that the related rise in CO<sub>2</sub> emissions increases the risk of flooding in a coastal village far away.
- A complementary task could present alternative measures, working around the question: ‘Could there be other solutions to building a new road?’ Possible solutions to be discussed could be:
  - To increase the accessibility of the village using public transport.
  - To set up an internet platform where people can organize carpooling to reduce the numbers of cars used every day.
  - To improve the mix of housing, work and leisure activities in the area to reduce the need to drive.
  - At an economic level, to work more closely with local producers to shorten the food supply chain and reduce the transport of goods.

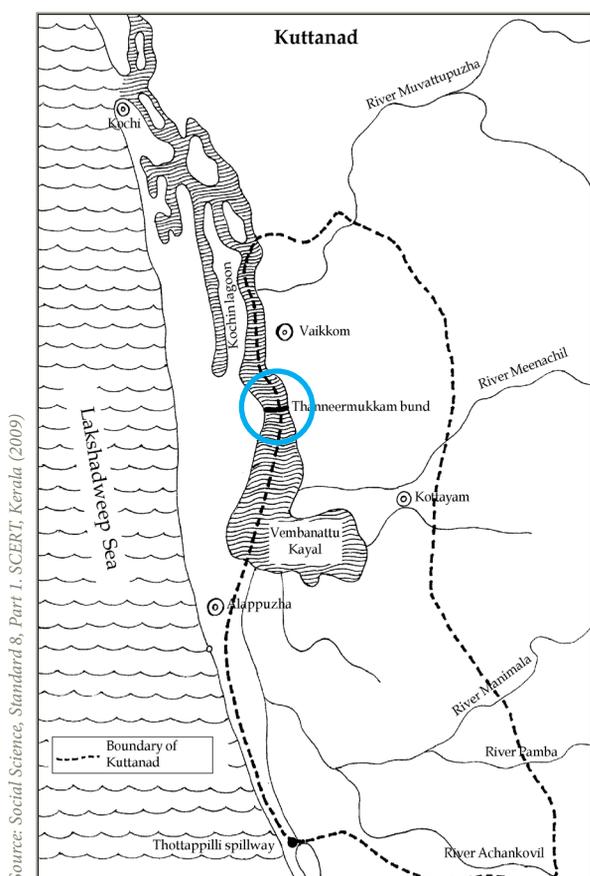
The learners would then return to the opinion they had formulated originally and take a renewed stand, giving one argument for it.

### 4<sup>th</sup> ESD-compatible existing example (lower secondary school)

This exercise for Grade 8 students is based on a chapter that looks at various aspects of Kuttanad, a leading agricultural region situated around Vembanad Lake in Kerala, south India. Kuttanad is a low-lying region (below mean sea level) and the lake is surrounded by wetlands of national importance.

The region is prone to floods every year during the rainy season. But before that, every summer, it is prone to the entry of salinity from the sea through the lake. The floods induce a natural flushing of pollutants and the increased salinity is good for the growth of river and sea prawns as well as fish species. However, these two factors have made cultivation a challenging task because they require water to be pumped out to make cultivation possible. Moreover, the water abundance makes only paddy cultivation feasible. Most of the cultivated lands seen today are those that have been reclaimed from the lake over a long period of time, implying a significant decrease in the lake’s surface.

Some major technological and chemical interventions have been fostered by the state to shape Kuttanad into an intensive agricultural area. These include the introduction of pump sets (to pump out water) and the use of chemical fertilizers and pesticides. Moreover, a salt-water barrier has been constructed between the lake and the sea (marked on the map as Thanner mukkom Bund) and a spillway built to control floods. These interventions – particularly the last two – are discussed in the chapter. The salt-water barrier curtails the entry of saline water into the lake and the spillway reduces flooding. This has helped farmers in Kuttanad by enabling them to grow an additional crop in the dry season. But it has resulted in a decrease in the number of prawns, fish and mussels. Moreover, it has curtailed the natural flushing of pollutants, which now accumulate in the lake and deplete the marine life. The accumulation of fertilizers in the lake waters have resulted in the overgrowth and spread of water weeds that adversely affect water transport and the everyday lives of the local people.



Learners are requested to:

- Make notes and present to the class on the subjects of:
  - saline water entry
  - flood
  - fishing
  - fertility of the region
- Reflect on the technological and chemical interventions (the introduction of the pump sets, use of chemical fertilizers and pesticides, construction of the salt-water barrier and flood-control mechanism) and their impact on nature and people.

### Analysis

At the level of content, this example focuses on human-nature interrelation, looking at environmental depletion in a region of national ecological importance, and at how technical innovations and chemicals affect the ecosystem and, in turn, the local community (the fisher folk). At the same time, it shows an increase in agricultural productivity important to another community (farmers). This considers actors and related power relationships (between landowning farmers and landless fisher folk, or between the state and local communities). It indirectly tackles scale because the innovations might be seen as positive from the perspective of the state but are detrimental to the local communities. Localization also plays a role because the salt-water barrier has different impacts on the south and north sides of the lake. At the level of pedagogical principles, learners deal with systems as they examine the effects of technological innovation on a territory and its inhabitants, effects with both pros and cons. Getting to know both sides of a story, and looking at the impact on local biodiversity and fisher communities, trains critical thinking. By examining the opposing economic advantages and social and ecological risks, underlying values are addressed.

### Contribution to ESD and further possible steps for embedding

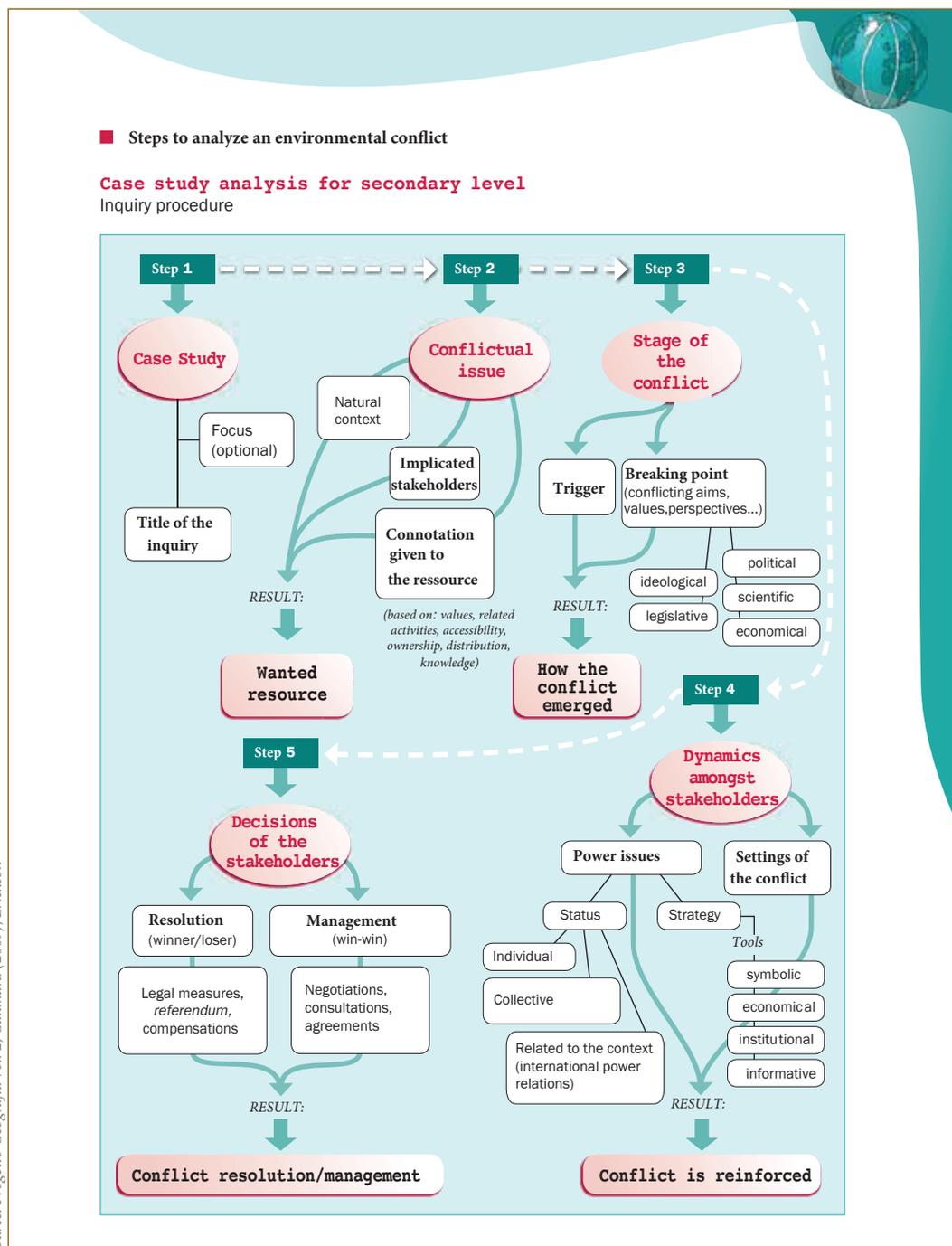
The impact on ecosystems and communities of technological measures linked to economic development is an important issue of sustainability. For further embedding of ESD, work on the principles of facing the future with creativity, fostering bonding and stewardship and acquiring knowledge (and to a certain extent participation) could be added because the textbook is rooted in a local-to-regional context. Learners could be asked to:

- Lead an inquiry among fisher folk around the southern part of the lake to understand how they cope with the situation and to find solutions that take the natural environment and their own interest into account. Discuss the results of the inquiry in class and then compare it with recent articles or studies on the subject (for example [www.zilient.org/article/kerala-fishermen-tackle-pollution-clam-theft-protect-wetland](http://www.zilient.org/article/kerala-fishermen-tackle-pollution-clam-theft-protect-wetland)). Write down one solution that allows the fisher folk to make a living while respecting the environment. Be clear about mentioning various sources, such as your interviews and recent articles. Further verification may be needed.
  - This would enable the students to create a link to local communities to better understand their perspective. It is also a way to see how local communities struggle to defend their interests while considering the ecosystem, tackling issues of social and environmental justice. It has the potential to increase ownership and responsibility, while looking at positive human-nature interactions as well as at the power of participating in societal processes. This opens up possible solutions for the future, linked to SD.
- Discuss with different groups of people, such as farmers and fisher folk, how they consider the option of decommissioning of the salt-water barrier. This option is frequently discussed in Kerala. Based on the results of your inquiry, hold a discussion in class to understand the various aspects, pros and cons of such a move and write down the main elements.
  - This task enables the students to use their earlier knowledge to imagine the future impacts of a change to the system. This would deepen their understanding of the system around Vembanad Lake. As this measure has not yet been taken, the learners' debate will stand in parallel with ongoing discussions in science and society, which is a situation they might encounter regularly if participating in SD processes.

### 5<sup>th</sup> ESD-compatible existing example (upper secondary school)

This exercise focuses on an inquiry method to illustrate how investigation is a characteristic feature of geographical education. The method is about identifying, analyzing and learning how to resolve a local environmental conflict. The textbook gives learners five steps to follow to search for information, build their knowledge (in groups of three or four) and propose a solution. The five steps are as follows:

- **The environmental conflict.** Identify a case study looking at local news (see Step 1).
- **The object of the conflict.** Search for further information around this case study (newspaper/television, internet, interview with identified actors) to clarify the issue (see Step 2).
- **The tipping point.** Looking at the chronology of events, identify the point when a situation starts to be conflicting. Look at what has led to this tipping point (see Step 3).
- **The multiplicity of actors and settings.** Reconstruct the chronology of the conflict and the role of different actors in different settings (see Step 4).
- **What to do?** Imagine possible solutions based on your analysis (see Step 5), trying to avoid reinforcing the conflict (see Step 4).



## Analysis

The addressed content depends on the issue being worked on but it will look at human-environment interrelations because the exercise deals with environmental conflicts. The method also fosters a close look at actors and related power issues. According to the conflict, localization, patterns and processes or spatial scale can also play a role. All pedagogical principles are more or less tackled by this exercise: the work on a local issue fosters a sense of stewardship; the conflict is seen as a complex system based on a human-nature relationship; the analysis of actors and related power relationships addresses critical thinking and a reflection around values; facing the future with creativity is required to imagine solutions; the analysis of options for conflict resolution and the group work ties in with the idea of collaboration and works on communication skills; the given methodology is a help for acquiring knowledge that can be used anywhere. For this last point, see Figures 3 or 8 for other examples.

As the textbook only indicates a method, the role of the teacher is of crucial importance because they offer guidance in the process and validate the results of the inquiry (this is already true for the suggestions made for the previous example). An example of a possible implementation of the method can be given in a teacher's guide but the content here is locally bound.



## Contribution to ESD and further possible steps for embedding

This example looks at conflict from the perspective of human-environment interrelations and power relationships between actors having potentially conflicting needs, interests and/or worldviews, which are recurring sustainability issues. It addresses many aspects, such as the value given to a resource or the legislative setting of a conflicting situation, and introduces the idea of the tipping point, which is important in ESD. The detailed method given for acquiring and analyzing geographical facts autonomously and the fact that the example points out the complexity of an issue are further contributions to ESD. Although this task already embeds many ESD-related elements, it would be possible to go further by:

- Comparing the imagined solution to the principles set out in the *Earth Charter* to decide whether the proposal leans towards SD.
- Closing the loop by looking at the possible effects of the imagined solution on the natural context (see Step 2).

## 6<sup>th</sup> ESD-compatible existing example: From a resource book to an ESD textbook (upper secondary school)

*Sprout: A Social Geography of Rajasthan* is a resource book (including very few tasks) that focuses on regional geography. The following extract on desertification is examined and completed with a possible set of related tasks.

### Desertification and restoration

Desertification is the transformation of arable or habitable land into deserts, which could happen naturally due to a change in climate or through human practices such as destructive land use. These imply a simultaneous transition of the landscape as well as of socio-economic relationships. The Space Application Centre of Ahmedabad reports that in 2009, 66 per cent of Rajasthan was under the process of desertification. A number of reasons are seen to be causing desertification, some of which are:

1. **Mining.** This economic activity involves the removal of the forest cover. This implies that the topsoil gets washed away by wind and water, ultimately giving way to desertification.

2. **Urban land use.** Industrial waste, pollution and the construction of buildings and roads on water drainage ways disrupt the natural flow of water.
3. **Ground water depletion.** Ground water is often pumped out at rates that are much faster than that at which nature can replenish it. This causes desertification of forests and farmlands.
4. **Waterlogging.** The Indira Gandhi canal was, among other things, constructed with the aim of controlling desertification by providing irrigation. It has increased arable land and given access to drinking water to many people. But with time, water seepage from the canal has caused waterlogging in numerous areas. At the same time, it has also brought to the surface the saline water that is found deep underground in most parts of Rajasthan. When saline water comes to the surface then plants cannot grow, which causes desertification.

Mitigating measures have been undertaken since 1952, when the Desert Afforestation Research Station was set up in Jodhpur to control desertification. Efforts were made to plant trees and to fix sand dunes. Trees protect against soil erosion from wind and rain, enrich the soil (with their falling leaves) and enhance existing humidity through evapotranspiration. Stopping dunes from moving helps to control the expansion of desertification.

At the same time, more and more voices underline that a number of practices in Rajasthan have traditionally taken care to protect the desert environments. For example, the construction of water harvesting systems such as *kuis* and *kunds*,<sup>7</sup> which collect groundwater in small quantities or rainwater and keep it from evaporating rapidly, are existing solutions for providing access to drinking water in not too densely populated areas. Such solutions were neglected when piped water supply was initiated and canals were constructed.

*Adapted from Y. Sunny (2014), Sprout: A Social Geography of Rajasthan, Eklavya Publications, pp. 127–128*

## Analysis

The presented content looks at human-environment interrelations, in this case the impact of human activities on desertification. The phenomenon is presented as having multifactorial causes (which require multifactorial solutions) and so is portrayed as a system with interrelated sub-systems. General patterns and processes, such as over-pumping ground water, can be observed over the territory. At the same time, the cause of desertification differs according to where it occurs (for example, deforestation or water logging), meaning localization plays a role. As there are no tasks, no pedagogical principles are addressed but the type of content presented opens the way for dealing with systems.

## Possible tasks

A very simple set of tasks, based on questions for learners to answer, can easily lead a step further into embedding ESD. Within this set of tasks, the focus is on dealing with systems, critical thinking, facing the future with creativity and acquiring knowledge. It also integrates the idea of scale at the content level. Possible questions would be:

- Do you think planting trees and fixing dunes will be enough to address desertification in Rajasthan? Justify your answer.
- Looking at the causes of desertification:
  - Find out one other measure that could be undertaken.
  - Compare it with the measure suggested by your neighbour, clarifying how your measures would fight desertification, and discuss if they can have a negative impact (for example, by decreasing the income of a group of people).

<sup>7</sup> *Kuis and kunds are underground wells, the former tapping groundwater or seepage from another source, the latter using a surface catchment area intended to collect rainwater.*

- Choose one measure based on your discussion to present to the class, explaining why you chose it, how it fights desertification and what negative impact it might have. Once the teacher has validated the answers, write down the measures presented by the class in a table like this one.

Measure	Ways in which it fights desertification	Possible negative impacts

- Choose the measure you think is the most effective, giving two reasons.
- Desertification is also linked to the fact that climate is changing at a global level.<sup>8</sup> Is there something that could be done to mitigate the impact of global climate change in Rajasthan? Will remedial measures taken only at the scale of Rajasthan help?
- What conclusion can you draw from all this? Write a summarizing paragraph. (An example for the teacher's guide: 'Desertification has many causes and many different and complementary measures, on both a local and global scale, are needed to tackle it effectively. Some of the measures have negative impacts on certain actors, which have to be taken into consideration.')
- You can then find out if desertification is an issue in your area. Look at its causes and at solutions that might have been developed. Compare your results with what you have just seen in this chapter.

<sup>8</sup>This implies that learners have already tackled climate change, allowing them to make links between chapters.

## 5.0

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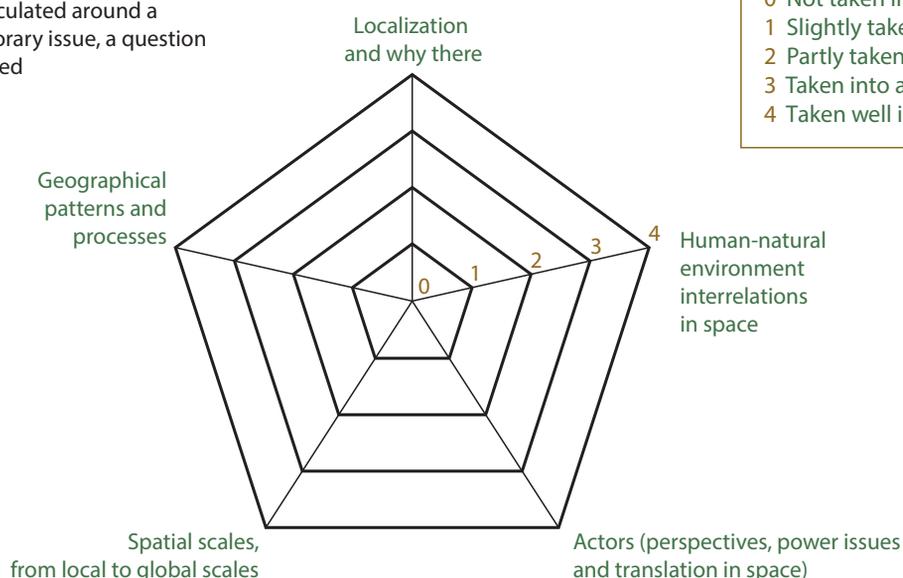
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## The 'ESD embedding in geography tool' at a glance

### How to select geographical content for ESD

To be articulated around a contemporary issue, a question to be solved



- Legend:
- 0 Not taken into account
  - 1 Slightly taken into account
  - 2 Partly taken into account
  - 3 Taken into account
  - 4 Taken well into account

ESD pedagogical principles	Bonding and stewardship	A reflection around values	Critical thinking
The learning activities of the textbook are organized so as to ....	... connect students to a community and/or the environment, allowing a sense of wonder and empathy as well as physical and emotional belonging so as to enhance their stewardship, sense of responsibility and willingness to act.	... make (underlying) values explicit so as to foster understanding of other people's perspectives but also an awareness of possible synergies or conflicting interests. Compare personal values to the idea of basic needs, intra- and intergenerational equity and a framework of values related to SD, peace and social justice to avoid relativism.	... provide learners with tools helping them to identify, understand and question the central and sometimes hidden issues of existing situations and ways of life, as well as mechanisms that lead to the successful implementation of sustainable practices (question the status quo and 'look behind the curtain'). Encourage learners to look at different perspectives, including conflicting ones, and to build a personal opinion.
<b>How it is tackled in the geography textbook</b>			
<b>Acquiring knowledge</b>	Help learners to gain SD-relevant knowledge by themselves (individually and in networks), look at it critically and compare it with existing knowledge. Provide methodologies or require learners to generate methodologies.		

Working on topic (link to curricula)

### How to create geographical tasks using ESD pedagogical principles

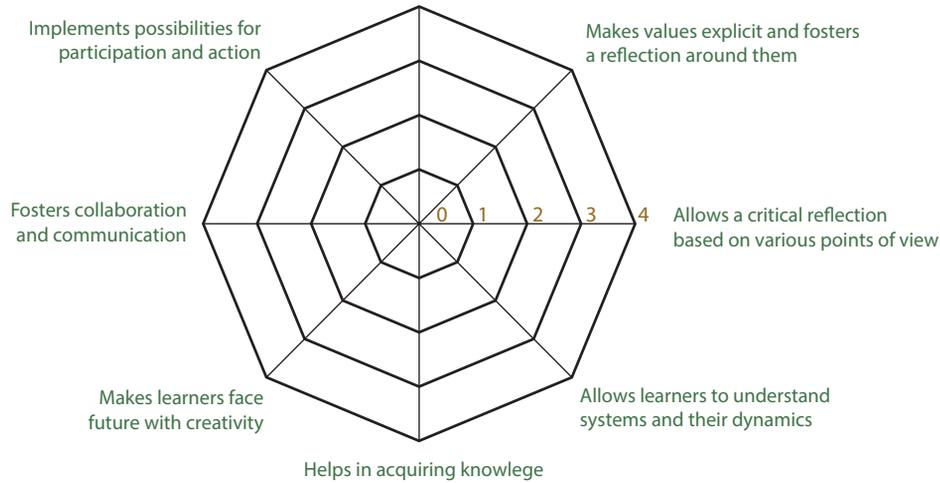
In each case, a link to the vision of SD should be done systematically, explicitly or implicitly.

Legend:

- 0 Not taken into account
- 1 Slightly taken into account
- 2 Partly taken into account
- 3 Taken into account
- 4 Taken well into account

The textbook ...

Opens up opportunities to create a bond with and a sense of stewardship for the environment and communities



Dealing with systems	Facing the future with creativity	Collaboration and communication	Participation
<p>... present situations and issues as a system in which nature and societies are intertwined and look at the dynamics of these systems while including diverse linear and non-linear interactions. Highlight how societies rely on nature, and how nature and societies affect each other.</p>	<p>... give room to imagination, divergent ideas and inventions to be explored, so that alternative visions of existing situations and ways of doing can be developed. Encourage learners' visions of possible futures and confront them with reality. Train them to anticipate the impacts of present actions on future generations. Teach learners to take advantage of change.</p>	<p>... help learners to know themselves (for example, their values and goals) and to recognize others' values and goals so as to acknowledge diversity. Encourage them to work together towards a common aim, acknowledging the benefits of working together but also the difficulties that can be addressed constructively. Make it possible for learners to elaborate opinions and choices. Train them to communicate clearly about collective analyses and visions or about personal choices and opinions.</p>	<p>Let learners take a stand, identify possible opportunities to act and develop implementation strategies: Is there a possibility to act? How would it work individually or collectively? Who do I have to consult? Where can I find help to support my project? Remark: although experiencing action can only be suggested by a textbook and has to be realized 'live', identifying strategies and planning a project can be worked on in the textbook.</p>

*‘There is a language of peace and it is one we  
need to use if we are to bring peace’*



# 5

## LANGUAGE

1.0	<b>Why language is an effective tool for making a better world</b>	157
2.0	<b>The contribution of language to ESD, peace and global citizenship</b>	158
3.0	<b>Embedding ESD in language textbooks – principles, tools and approaches</b>	160
3.1	Principle 1: Use the ‘open content space’ in language for sustainable development content	160
3.2	Principle 2: Use language as a ‘power tool’ to create a peaceful, just and ecologically sustainable world	162
3.2.1	Developing language as an effective tool for the communication of ESD	162
3.2.2	Developing critical thinking skills through language for ESD	163
3.2.3	Using authentic texts and real-time engagement	164
3.2.4	Media literacy – another way to develop critical thinking skills	164
3.2.5	Using language for peace	165
3.2.6	Using language for social justice	167
3.2.7	Language for advocacy	170
3.2.8	Developing language as a tool for identity through mother-tongue use	171
3.3	Principle 3: Use literature/language to enable learners to make informed decisions and take action as responsible global citizens	172
3.3.1	Developing critical interpretation and thinking skills	172
3.3.2	Reading ecocritically	173
3.3.3	Clarification of values through literature to make learners aware of the values needed to create a just and sustainable environment	174
3.3.4	Using literature to develop empathy and the ability to see varying perspectives, including a future’s perspective	175
4.0	<b>Examples</b>	176
4.1	Methods for embedding ESD in language textbooks	176
4.2	Example of a language textbook exercise with ESD embedded: my community	176
4.3	Example of a language textbook exercise with ESD embedded: peace and conflict	181
5.0	<b>References</b>	185

## 1.0

# Why language is an effective tool for making a better world



THE POWER OF WORDS to shape us and our world, to determine our relationships with each other and to our environment, has long been recognized. Eagleton (1998) discusses this idea as he explores the rise of English (literature) and its shaping of society. The relationship between language and society is fully expressed in the theories of language which posit the idea, at varying levels, that the world is a construct of language (see Saussure, 1978; Derrida, 1976, as cited in Eagleton). Postcolonial literary theory, for example, exposes the power of language as it explores how long-lasting characterizations of nation groups have been produced through language and have led to their marginalization (see Said, 1978; JanMohamed 1983). In addition, the relatively new field of ecocriticism uncovers how, through language, various conceptualizations of the environment have been produced, evoking particular feelings, attitudes, perspectives and values in regard to the environment. In fact, ecocriticism, with its emphasis on ways of reading and writing the environment and human beings' relationship to it, displays the power of language to shape our responses to our world. More currently, the authority of language has been seen in the impact of social media and marketing in determining who holds power and who does not in our societies. The implication of this for education for sustainable development (ESD) is that language provides a tool for shaping the world as desired.

In looking specifically at the language of English for ESD, we are, however, mindful of English's historical dominance in the colonizing process, of 'installing itself as a "standard" against other variants which are constituted as "impurities"' (Ashcroft, Griffiths and Tiffin, 1997, p. 283). Yet as Brathwaite (1997, p. 284) in the same text has argued, the production of 'Nation Language' in the Caribbean region demonstrates the

vigorous success of linguistic variations of English. Equally important is the position taken by the Caribbean poet and Nobel Laureate, Derek Walcott, who asserts that the 'English language is nobody's special property. It is the property of the imagination: it is the property of the language itself,' (Walcott, 1986). Interestingly, in the *German Curriculum Framework, Education for Sustainable Development* (2016), English is identified as the most important medium of global language, although, admittedly, not the only one (p. 164). The *Position Paper* of the National Focus Group on Teaching of English in India (2006) also affirms the importance of English: 'English is in India today a symbol of people's aspirations for quality in education and a fuller participation in national and international life,' (p. 1).

We are also aware that the dominance of English can pose a threat to linguistic minorities. The *Global Education and Monitoring Report 2016*, in drawing our attention to the need for addressing inequality, lists linguistic minorities among the vulnerable groups being discriminated against. Moreover, language in education policies can be a source of wider grievances. In multi-ethnic countries, the imposition of a single dominant language as the language of instruction in schools, while sometimes a necessity, has been a frequent source of grievance linked to wider issues of social and cultural inequality (UNESCO, 2016). By one estimate, over half the countries affected by armed conflict were highly diverse linguistically, making decisions about the language of instruction a potentially divisive political issue (Pinnock, 2009; *Global Education Monitoring Report*, 2016, p. 127).

Yet English, despite its hegemonic relationship to other languages, which may produce tensions and divisions, is a global language – a *lingua franca* – and

one of the six official languages of the United Nations. As such, English offers the world a space in which we can speak to each other and build relationships across borders. In considering, therefore, the value of English for sustainable development, peace and global citizenship, we note that one of its key attributes is the opportunity it presents for building bridges across different linguistic communities, for creating a common ground among diverse groups of people and so enabling effective communication.

There are, of course, other language issues that we need to consider as we engage with using language as a tool for ESD. These include how to use language to build social inclusivity, for example, how to ensure that the gender use of English does not exclude or privilege one gender. In addition, there is the issue of cultural context. Language is a tool of culture and identity. Language teaching and learning must now emphasize the importance of culture, particularly in teaching English as a second language or a foreign language – the culture of the learner is expected to provide the context even as other cultures or English culture is acknowledged. We also have to attend to

the use of language specific to different disciplines, for example, the technical, specialized language of science. There is, therefore, the need for ‘translation’ to reach a wide community of readers and to ensure inclusivity (see the Science chapter for a discussion on science and language).

How then do textbook authors embed ESD in language? In this chapter, we discuss first the potential contribution of language to ESD, peace and global citizenship and then how to ensure this contribution is made, in other words, how to infuse or embed ESD in language textbooks.

In addition, we recognize the varieties of English that exist and their various relationships: English as a foreign language; a second language; a native language; the official language in places where other languages or mother tongues exist and English as a *lingua franca* – a global language. The guide for embedding ESD in English language textbooks, however, does not distinguish between these groups and aims instead for a general view that will be applicable to all at various levels.

## 2.0

# The contribution of language to ESD, peace and global citizenship

Language, as we discussed earlier, can contribute to ESD by using its power to ‘create’ the world that is desired. To do this, we must pay close attention to the functions of language.

*Language can also contribute to ESD through the development of critical thinking skills. This will help learners to be more fully prepared to read and interpret their world accurately and to discern truth*

The primary function of language is to communicate. Using a *lingua franca* such as English, which people learn so as to communicate with each other effectively, can enable the building of a global language community with a shared understanding of people and place. This, in turn, enables the development of a common understanding of the concept and practice of sustainability.

Traditionally, the thrust of language teaching and textbooks has been to develop effective communication skills. To do this, the language skills of reading, writing, listening and speaking have been the focus of language teaching. More specifically, the learning of these skills has meant the promotion of critical thinking skills, the practise of various types of discourse and the accurate use of language in terms of grammar, structure and mechanics. By possessing these skills, individuals have the fundamentals for effective communication. To some extent, language textbooks have also traditionally delivered content for ESD. Prose fiction, poetry and drama have addressed sustainable development themes, issues and topics at varying levels.

Language teaching and textbooks can, however, contribute significantly more to ESD.

With the inclusion of the vision for a peaceful, just

and ecologically sustainable environment, language content can be more focused on sustainability. In effect, the ‘open content space’ in language can be used to embed sustainable development themes, issues and topics. By including authentic and real-world materials and tasks, the connection between classroom and community is strengthened. As a result, students learn to attend to their community and to become active local and global citizens (see Down, 2010).

Language can also contribute to ESD through the development of critical thinking skills. This will help learners to be more fully prepared to read and interpret their world accurately and to discern truth. Learners will, for example, identify stereotyping/ racial profiling that can lead to injustice, comprehend ‘basic’ science and economic facts that will prepare them to address environmental, social and economic crises, and recognize the various fallacies in public

debate that would seek to obscure the threat posed to human survival by current human activity.

Enabling learners to make informed decisions and take action as responsible global citizens is also another way in which language can prepare a society to address sustainable development issues. Critical thinking and interpretation skills can be honed by reading literature. The clarification of values, the development of empathy and being open to multi-perspectives – including a future’s perspective – can be encouraged. Equally important, students can explore representations of, and humans’ relationships to, the environment intimately through literature.

The path to sustainability requires people to make substantial changes in the way they perceive and shape the world. Language as a ‘power tool’ can enable such changes. Through exercises, activities and tasks using language for peace, social justice and advocacy, language textbooks can advance the world’s movement towards sustainability. And imbricated in this is language learning that provides the opportunity for people to know who they are and how to live together. Language learners can thus be enabled to create a sustainable world.

All the possibilities that language offers will be discussed fully when we look at how to effect them in section 3.

What is abundantly clear, is that *more is required of our language textbooks and language teaching if we are to employ English more fully to help transform our societies.*

Textbook writers and publishers of English language textbooks, therefore, have an important role to play in creating a sustainable society. In the pages that follow, we will discuss specific ways to embed ESD in language textbooks and so help to usher in, through language, positive changes for our world. These specific ways are to:

**Use content in language through the ‘open content space’.**

- Ensure the inclusion of authentic materials and tasks so that there is a strong relationship between the classroom and communities and a real-world connection between language textbooks and society. (Authentic materials and tasks are defined as materials used and tasks done in everyday life.)

**Recognize and use language as a ‘power tool’ to create a peaceful, just and ecologically sustainable world.**

- Develop language as an effective tool for communication and advocacy for ESD.
- Use language for peace (non-violence and non-discrimination).
- Use language to address social justice.
- Develop language as a tool for identity by incorporating non-English mother tongues in the English language textbook.

**Use literature to enable learners to make informed decisions and take action as responsible global citizens.**

- Develop through literature critical thinking and interpretation skills.
- Clarify values through literature so learners become aware of the values needed to create a just and a sustainable environment.
- Develop through literature empathy and the ability to see varying perspectives, including a future’s perspective.
- Explore through language with literature:
  - (i) representations of the physical environment and its relation to social and economic environments;
  - (ii) human beings’ relationships with the physical environment so the environment is a key focus.

*It is abundantly clear that more is required of our language textbooks and language teaching, if we are to employ English more fully to help transform our societies*



## 3.0

## Embedding ESD in language textbooks – principles, tools and approaches

In this section, we will explore how to embed ESD in language textbooks and so realize language's potential to contribute to sustainable development. We propose that embedding ESD in language textbooks will advance the teaching of English beyond simply teaching a skill. It deliberately employs English to create a better society.

The examination of several language textbooks reveals the gaps that exist in terms of an ESD focus. Many books do not explicitly express in their objectives or content the big goal of enabling effective communication among peoples and of using language to build sustainable societies. Many books speak of teaching grammar, the mechanics of English and writing and reading skills. Some may, for example, take a thematic approach that uses students' interests to teach English. John Warriner's *English Composition and Grammar*, one of the most comprehensive language texts, identifies the purpose of the textbook as helping students master the skills required for the effective use of standard English to help them speak and write better English. The *Kaleidoscope* series, in its *Teacher's Guide* (Ginn), takes it a step further. The writers make the point that language education is not just to teach pupils about language but also to help them learn through language. It is, however, in the *English Alive* series (Nelson Thornes) that we see a goal that comes closer to that of a text for ESD. In this series, the writers include as one of their aims: 'presenting a moral purpose common to all major religions when that is possible'. The qualifier, 'when that is possible', suggests its secondary status and the text itself may be said to address that goal only incidentally. The text series in which English language teaching and learning appears to be most oriented towards ESD is that of the *Notting Hill Gate 6A Advanced Course* textbook. We will look more closely at this text in our discussion of the principles for and approaches to embedding ESD.

The principles that guide embedding ESD in language textbooks are (these have been expanded already in section 2):

**Principle 1** Include SD content in language by using the 'open content space'.

**Principle 2** Recognize and use language as a 'power tool' to create a peaceful, just and ecologically sustainable world.

**Principle 3** Use literature to enable learners to make informed decisions and take action as responsible global citizens.

These principles are all aligned to ESD principles/competencies, which have been discussed in the Introductory chapter.

## Box 1

### ESD competencies

Acquiring knowledge about and for sustainable development; thinking critically; solving issues/problems/conflicts; using 'authentic' material; targeting a 'real' audience; having a purpose linked to sustainability vision; engaging in values reflection and clarification; developing empathy; developing a future's perspective; learning advocacy skills.

## 3.1

## Use the 'open content space' in language for sustainable development content

### Principle 1

In discussing this principle, we look at:

- Embedding sustainable development content in the 'open content space' in language textbooks.
- Ensuring the inclusion of authentic materials and tasks so there is a strong relationship between the classroom and communities, a real-world connection between language textbooks and society.

Knowledge about and for sustainable development has been identified as an ESD competency that learners need to acquire. Language offers a place for sustainability concepts, ideas and issues in what we refer to as the 'open content space'. Content, other than language-specific content, is required to teach language and to develop the competencies. Conventionally, textbook authors and language teachers have organized this content along themes or according to general interest – and sometimes this selection appears to be very idiosyncratic. This

*Embedding ESD in language textbooks will advance the teaching of English beyond simply teaching a skill. It deliberately employs English to create a better society*

is, however, clearly a space in which sustainable development ‘content’ can be inserted. Topics could include climate change; peace; planetary boundaries; environmental degradation; fair trade; equity; poverty and hunger. Or topics can be based on developing an appreciation for (and an understanding of) place as the social, economic, physical and cultural issues are explored. The United Nations Sustainable Development Goals website<sup>1</sup> can be used as guide for such selections, especially as each goal is accompanied by global narratives that reflect on it. (The Introductory chapter and the UNESCO website What is ESD?<sup>2</sup> also suggest criteria for selecting sustainable development topics. See also *The Great Derangement* by Amitav Ghosh).

In selecting content, textbook authors will draw on other disciplines and, at times, will need to ‘translate’ the technical language of the discipline into language appropriate for their target learners (see the Science chapter for a discussion of the language of science).

The idea of using the ‘open content space’ in language is illustrated in the approach of Jessie Singer and Ruth Shagoury, who created a unit on social activism when teaching literacy skills to a group of adolescents (Singer and Shagoury, 2006). Singer and Shagoury tell how, through teaching reading and writing, they created a unit that tasked students to explore issues of equity. By selecting reading material by South African writers, such as *Kaffir Boy* by Mark Mathabane, as well as short stories by Peter Abrahams and Nadine Gordimer, they introduced their students to international literature that explored issues of race, equity and identity. The students’ literacy skills were developed as the teachers provided guidance on how to understand difficult texts and their writing skills were honed. By integrating their approach into reading and writing instruction, Singer and Shagoury provided the foundation for students to engage in social activism.

What we observe here is the transformation of a literacy class by the selection of texts that deal with real-world sustainability issues and tasks that require students to take action not just in the classroom but in wider society. The teaching of literacy skills – how to read and interpret, how to write effectively and accurately – laid the foundation for this. In other words, the students were given the ‘big purpose’ of literacy, showing it to be a way to understand the world and a means to transform that world. Therefore, a language textbook with ESD embedded will, by teaching language skills, also have content and activities related to sustainability issues.

The textbook *Notting Hill Gate 6A Advanced Course* and examples at the end of this section also illustrate this use of ‘open space’. The themes and topics in the examples are based on Sustainable Development Goal 16 (peace and justice) as well

as the sustainability theme of ‘appreciating place/ community and engaging with community or taking action for community’. In the *Notting Hill Gate 6A Advanced Course* textbook, one unit engages with the sustainability theme ‘economy and social justice’, specifically fair trade. The unit is titled *Global Economy and Sweat Shops* and has sub-topics such as ‘fashion facts’. Tasks include conducting research on ‘clean clothes campaigns’.

Another example of using the ‘open content space’ of English teaching is the *Learning English Through Social Issues Resource Package* (Sek 2007)<sup>3</sup> developed for the senior secondary curriculum in Hong Kong. A variety of language points – causation expressions, comparison of perspectives, debating skills – are taught through the discussion of social issues. The social issues chosen in the package include common topics such as homelessness, deforestation, obesity, the right to life versus the right to die, but textbook writers could easily choose issues that are more relevant to their respective target audiences. The authenticity and relevance of topics are among the most effective factors in motivating learning. Given that issues relating to the sustainability of society naturally concern everyone, students are able to see the purpose of acquiring the language skills necessary to tackle them. To encourage students to discover more about the topics by themselves and use more of the target language outside class, research skills – such as how to conduct interviews, record observations and design surveys – can also be included. This gives students ownership of their learning and exemplifies the complementary nature of language teaching and ESD content embedding.

The Hong Kong example shows the critical issues that can inform the content material for language textbooks with the goal of developing students’ social, economic and environmental knowledge. It also suggests ways of encouraging students to change perspectives and to take action to address these issues while teaching the specific language skills of listening, speaking, reading and writing.

Using today’s critical issues as content to develop these language skills indicates how ESD can be embedded in a language textbook. Moreover, it shows how language teaching can be used to help create a better world.

It is important to note, however, that including sustainability issues and themes does not mean

*Using today’s critical issues as content to develop these language skills indicates how ESD can be embedded in a language textbook. Moreover, it shows how language teaching can be used to help create a better world*

<sup>1</sup> Sustainable Development Goals – 17 Goals to Transform our World. Available at [www.un.org/sustainabledevelopment/sustainable-development-goals/](http://www.un.org/sustainabledevelopment/sustainable-development-goals/)

<sup>2</sup> What is ESD? Available at <http://en.unesco.org/themes/education-sustainable-development/what-is-esd>

<sup>3</sup> Available at [www.edb.gov.hk/attachment/en/curriculum-development/kla/eng-edu/social%20issues\\_teaching%20resources\\_071211.pdf](http://www.edb.gov.hk/attachment/en/curriculum-development/kla/eng-edu/social%20issues_teaching%20resources_071211.pdf)

excluding conventional themes, such as love, birth, death and growing up. In fact, these themes are extended and deepened because the sustainable development content opens up a wider sphere of concerns, takes a holistic view of life and encourages a greater connectivity between students and their community. Moreover, by giving students a 'template' whereby language skills are taught through the consideration of local and global survival issues, they will be able to continue the work in their communities long after class is over.

*Language textbooks, now more than ever, need to focus on providing information, tasks and exercises that teach students how to communicate their ideas, opinions and emotions in ways that will open a dialogue that leads to the 'truth'*

There is, however, a possible limitation to the use of 'open content space'. At present, language education in Europe is moving more than ever towards being integrated into other content areas and disciplines in the curriculum, instead of being taught in dedicated language classes (Thurmann, 2013). However, although the value of this approach has long been recognized, its limitations can be seen if it becomes the sole means of delivering language education. For textbook writers focusing on English as a second or foreign language, this approach is not viable. Moreover, the curricula for primary and secondary schools in many countries have dedicated sessions for language education. These require English language textbooks, not just subject content texts featuring aspects of language teaching.

### 3.2

## Use language as a 'power tool' to create a peaceful, just and ecologically sustainable world

### Principle 2

In discussing this principle, we look at developing language as an effective tool for:

- Communication.
- Critical thinking.
- Peace.
- Social justice.
- Advocacy.
- Identity.

The path to sustainability is one that requires substantial changes to the way we perceive and shape our world. Language has the power to influence this significantly. Through language we can help to create and construct a peaceful, just and ecologically sustainable world. As discussed in section 2, this involves developing effective communication and critical thinking skills, learning to create through language a peaceful environment, employing language to address social justice issues, recognizing the power of language for advocacy and understanding language as a means to develop one's identity.

### 3.2.1

## Developing language as an effective tool for the communication of ESD

Developing an effective tool for communication is the overarching and specific goal of language education. As discussed in section 2, English can build a common ground on which we can share information, ideas, emotions and create connections between diverse groups of people. When used as an effective tool, language also helps to clarify ideas and emotions and, in general, helps people to understand themselves, others and their environment.

The need to communicate effectively has acquired a certain urgency given the growing need to deal with complex issues such as high levels of consumerism in a world of finite natural resources, the growth in technology and its devastating effects, and immigration and the refugee crisis. Language textbooks, now more than ever, need to focus on providing information, tasks and exercises that teach students how to communicate their ideas, opinions and emotions in ways that will open a dialogue that leads to the 'truth'.

Exercises for creating and analysing dialogue on a number of sustainability issues are crucial. By making references to TV shows and using material from websites, journals, magazines and other sources, such as the Global Oneness Project,<sup>4</sup> textbook writers can prompt discussion of real-world topics. These could include extreme weather conditions, energy sources and fracking, consumption, land use (housing versus farmland and forests) or refugees and migration. Textbook writers can provide students with questions that help them probe what is being communicated, how it is being communicated and offer them ways of discerning the 'truth' in such dialogues.

Textbooks will also need to include topics that raise the issues of 'how, what and when' to communicate. What is the best way to communicate a message? When is the best time? What type of language should be used, what diction, tone, emotive words, metaphorical language should be used? Students also need to learn the importance of identifying their target audience, the 'receivers' of their communication. Practice in identifying what an audience needs and what the sender wants them to do with the information sent is also important.

A useful exercise would be to provide students with the facts about a critical issue such as biodiversity

<sup>4</sup>The Global Oneness Project offers free multicultural stories and accompanying lesson plans for high school and college classrooms. Available at [www.globalonenessproject.org/library/films](http://www.globalonenessproject.org/library/films)

loss (or any of the other sustainability issues listed in section 2) and then ask them to create a short presentation on it. They will need to determine the audience, the language to be used and the discourse form (for example, narrative, exposition) and the presentation format. Most important, students should be encouraged to see the urgency of their task and be prepared to communicate in a clear way the appropriate content of the critical issue.

Another important textbook task is that of introducing the students to the process of communication and helping them to understand the possible barriers to effective communication. Practice exercises in active listening; recognizing verbal and non-verbal communication; engaging in pro-social behaviour (being polite, respectful, waiting one's turn); learning to negotiate, persuade and influence; learning the language of conflict resolution and mediation are all important in developing students' communication competencies. These exercises can take the form of games followed by in-depth reflection/processing. Process drama provides another means of engaging and reflecting on communication lessons (see Howell and Heap, 2001).

A number of these communication topics are present in language textbooks. There needs to be, however, more emphasis on the development of communicative skills so that students are prepared to be better communicants. Given the mass of information that people now have to process, the resulting mental confusion and the tension of living in this century, it is essential to have more open and honest communication. It is from such quality communication, and listening actively to hear another's point of view (rather than just listening to respond), that wholesome human relationships can develop. And it is from here that understanding and connecting with self, others and place can develop the foundation for a peaceful, just and safe world.

### 3.2.2

## Developing critical thinking skills through language for ESD

To build effective communication, we need to develop critical thinking skills. Their importance to sustainability has been emphasized in the Introductory Chapter. This is also a major part of language education and is seen, in its most basic form, in the teaching and learning of comprehension skills at the literal, inferential and evaluative levels.

The development of these skills can help students make sense of complex subjects, such as sustainable development. In fact, the complexity of sustainable development can be seen in the many ways the

concept has been interrogated. Nolet (2016), for example, questions the moral prerogative of those who have benefited from development to determine if and how others should benefit. Sachs (2016) raises the issue of population growth and a finite earth and Satterthwaite (2009) responds to that issue by asking if it is more a matter of a growth in consumers.

Such multifaceted and intricate issues demand a public that is not only well informed but that has been taught critical thinking skills. More than ever, the teaching of such skills must be deepened. Sterling (2010 p. 33) argues that for a transformative learning experience, the following thinking skills need to be emphasized:

*Holistic:* 'how does this relate to that?; 'what is the larger context here?' *Critical:* 'why are things this way, in whose interests?' *Appreciative:* 'what's good, and what already works well here?' *Inclusive:* 'who/ what is being heard, listened to and engaged?' *Systemic:* 'what are or might be the consequences of this?' *Creative:* 'what innovation might be required?' *Ethical:* 'how should this relate to that?; 'what is wise action?; 'how can we work towards the inclusive well-being of the whole system – social, economic and ecological?' *Practical:* 'how do we take this forward with sustainability in mind as our guiding principle?'

Language education with an ESD perspective offers textbook writers deeper levels on which comprehension questions are usually based. The literal, inferential, critical, appreciative and evaluative can be expanded to reflect more of what Sterling has highlighted.

The exercise that follows illustrates how language textbook authors can develop critical thinking skills with sustainable development in mind. Textbook authors could select a sustainable development issue, for example, environmental loss and poverty. The tasks selected could include brainstorming to find out what students already know about the issue and to identify their views of existing opinions, attitudes and claims. This could then be followed by viewing a video. In this exercise, the YouTube video suggested is *Massa God Fish Can Done*, a documentary from the Nature Conservancy, which introduces students to the cyclical problem of over-fishing, the destruction of the fishing industry and the poverty of the fishers. Using open-ended and guiding questions, the exercise would require students to think about the situation in the video holistically by having them consider the larger context and the local situation in connection to the global context. Students could also be asked to review their own as well as received opinions on the subject by having them consider how ideas about poverty are reflected or contested in the video. They could then be engaged in looking for connections between the socio-economic issue of poverty and the environment.

An extension of the exercise would have them analyze the video further by thinking about the causes and the effects of the situation and how those effects also lead to the causes.

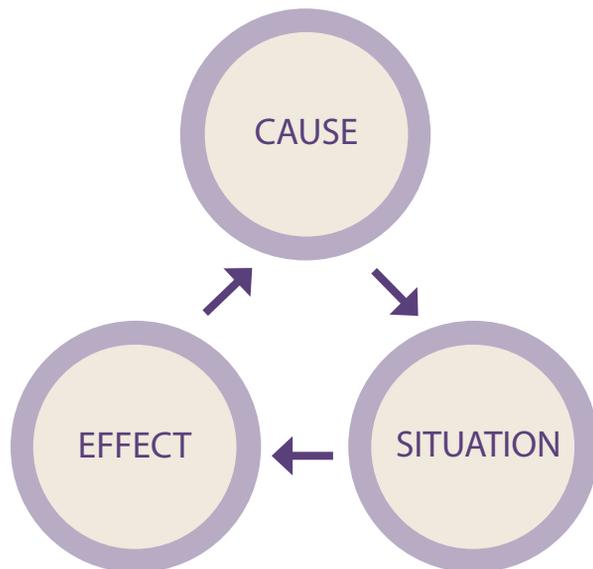


Figure 1: The interrelation of cause and effect

Students could then be asked to think ethically, creatively and practically as they identify solutions that could save the fish and remove the threat of poverty from the fishers. Reflection on the process of comprehending the situation, which could then follow, would provide students with a 'template' for thinking critically about other issues.

Complementing this, students could be asked to analyze a current news headline or story related to fishing, such as 'Massive Basa fish processing plant opens in St Elizabeth today; over 100 jobs and counting' (*The Jamaica News Observer*, 20 January 2017), in light of the aforementioned video. The language exercise now moves into the area of media literacy. The exercise could ask students to list questions that seek answers to fill the gaps in the story; to identify the perspectives of the narrative; to reflect on who benefits and how much; to consider the environmental and employment implications. The photograph accompanying the news story could also be content for students to analyze. In this regard, students could be given guiding questions that help them to analyze media photos, for example, who or what is in the photo? Who or what takes centre stage? Why? How? What is the effect of this? What is omitted from the photo? What appears on the margins?

The language textbook exercises described here engage students with sustainable development content while developing their critical thinking skills. In effect, they provide an opportunity for the students to apply their critical thinking skills to a real-world situation.

### 3.2.3

## Using authentic texts and real-time engagement

We also wish to emphasize the importance of the authenticity of the material. Students are being invited to 'read' their local and/or global community in real time. Language textbook writing exercises could follow a similar pattern. The language specifics of types of writing (expository, narrative, argumentative, creative), sentence structures, target audience or grammar and mechanics could be combined with writing tasks that are directly connected with students' communities beyond the classroom. Students could be asked to write on the subject of fishing for their school newsletter, make a poster for their community on the dangers of over-fishing or prepare a piece for their school's Facebook page. Interviews with local fisher-folk could also form the basis for their own video or news story.

Engaging students in language classes often requires an active approach to language teaching. When students see that their writing has a real audience, has a purpose beyond gaining a grade and connects to a vision of transforming their world, they are more likely to attend to that work than they would otherwise. English language textbooks that engage students in this way will exemplify a language text with ESD embedded.

### 3.2.4

## Media literacy – another way to develop critical thinking skills

Given the complexity of the news, the various ways in which information is presented and the influence of different interest groups, English can enable the development of media literacy. Sustainable development goals and issues often engender much public debate because they challenge huge corporations with vested interests in maintaining the status quo. Climate change, for example, has given rise to huge debates, with some people, even today, still questioning its reality. Language textbook activities can help students learn to analyze the language of the media to detect fallacies and vested interests and learn who to trust in this critical era.

'All media aren't created equal,' Paul Fleischman (2014, p. 154) has asserted. And language as a medium can be employed to test that. Language includes the necessary tools to identify bias, circular arguments, assumptions and emotive diction to strip language itself to its essentials – the facts. Exercises on this aspect – language and logic – are generally included in teaching persuasive writing/building the

*When students see that their writing has a real audience, has purpose beyond that of a grade and connects to a vision of transforming their world, they are more likely to attend to that work than they would otherwise. English language textbooks that engage students in this way will exemplify a language text with ESD embedded*

argument. Debates and discussions usually provide opportunities for practice here. The lesson on the subject of peace and conflict later in this chapter includes one such exercise.

### 3.2.5

## Using language for peace

In this section, we uncover the power of language to shape our thoughts, our feelings and to construct our reality. We highlight, specifically, peace and social justice as they are two key components of the concept of sustainable development and ESD.

Textbook writers engaging with language for peace can make concrete many of the ideas and principles identified in the Preamble to the *UNESCO Constitution*. The Preamble tells us that ‘since wars begin in the minds of men, it is in the minds of men that the defence of peace must be constructed’. The Preamble thus states that war and peace are foremost constructs of language. Desires become translated into thoughts, thoughts into words and words into action. This picture is further detailed in the UNESCO publication *Peace Education, Framework for Teacher Education*.<sup>5</sup> Viewing peace holistically, the writers describe total peace as a combination of inner peace, social peace and peace with nature. That such acts are represented and mediated through language points to language’s potential to create peace or war. The text, moreover, argues for the development of skills in critical thinking and problem solving for peace.

One of the major contributions that language can make to ESD is by focusing on the use of language for peace. In this case, language addresses Sustainable

Development Goal 16 (peace, justice and strong institutions). The childhood rhyme, ‘Sticks and stones may break my bones but words will never hurt me,’ has been proved to be spurious time and again – by spreading hatred, words can hurt and cause death.

Yet words also have the power to heal. There is a language of peace and it is one we need to use if we are to bring peace. Through this language, as Rebecca Oxford (2013) affirms, we are offered the possibility for transforming our societies. The language of peace enables us to defuse situations of violence, deal effectively with conflict and improve our relationships generally. She also points out the language of peace not only offers us the vocabulary for conversing about peace but has transformative qualities. Oxford describes it as a language with many different tones: friendly, respectful, reverential, ecstatic, gently consoling and artistic. The possibilities for including this in the language textbook are many. Textbook writers could consider exercises in which students brainstorm, research and display peace words using different media. Students could also be asked to identify or create dialogues with tones that are friendly, respectful, reverential, ecstatic, gently consoling and artistic as a way to learn to use language with tones that are peaceful (see also Ghosen, 2005).

Describing several peace-building activities that employed story-telling and drama, Modi (2014b) observed that they challenged the idea that ‘the English language classroom is meant only for the de-contextualized transmission of skills or the polishing of grammar and vocabulary’. He suggests that we use questions at the level of recall, inferencing and critiquing in order to help students to discern different perspectives and reflect on important subjects such as compassion, care and loyalty using

*There is a language of peace and it is one we need to use if we are to bring peace*

<sup>5</sup>Available at [unesdoc.unesco.org/images/0015/001502/150262e.pdf](https://unesdoc.unesco.org/images/0015/001502/150262e.pdf)



stories and drama. Modi's comments indicate the kind of activities that can or should be included in language textbooks with an ESD perspective.

In addition to this, textbook authors in engaging with language for peace should consider emphasizing the language needed for social behaviour. At a basic level, this includes language for simple social courtesies: 'How are you?' 'Nice day.' 'Have a good one.' 'Thank you.' Yet such simple social uses of language – uses that could be perceived as nothing more than insignificant rituals – can create harmony. The language of social courtesy acknowledges others and creates a space for community. A society's dismissal of this function of language can, in fact, lead to a loss of opportunity for connecting and valuing the simple existence of others.

Language for pro-social behaviour, as described in *Speaking the Language of Peace* (Duffy, 1995), provides an extension of that basic language function. The writer addresses language for pro-social behaviour, such as cooperation, collaboration, affirming others and expressing feelings in ways that do not hurt others, as well as behaviour that promotes peace. We also think of the role of language in other social interactions – such as disagreeing with someone, making a complaint, being critical, responding to criticism – and consider how language can be used to promote harmony or discord in these situations. Evident here is the potential for language textbooks to bring peace through an analysis of language for social behaviour.

*Language for pro-social behaviour provides an extension of the basic language function. The writer addresses language for pro-social behaviour, such as cooperation, collaboration, affirming others and expressing feelings in ways that do not hurt others, as well as behaviour that promotes peace*

Aggression and hate are types of behaviour that prevent the creation of peaceful and sustainable societies. Language – the choice of words, structure of sentences and tone – also plays a role in promoting such behaviour. Identifying the use of such language in aggressive and hate speech is a key step towards changing violent thinking, speech and behaviour. Language textbook writers can address citizenship education's concern with hate speech – for example, as set out in UNESCO's *Countering Online Hate Speech* (2015) or the *Online Hate Prevention* resources in Australia<sup>6</sup> – by promoting the knowledge and skills to not only identify hate speech but produce messages to counter it.

Attending to the emotive level of words (tone, connotative and denotative word meanings) is essential in identifying and transforming the language of hate into the language of peace. Textbook exercises can encourage students to do this and to practise translating the language of violence into the language of peace. Students' work with words and phrases and the examination of these in different contexts (situations of conflict, harmony, care, compassion) can lead also to in-depth work on language as a means to develop relationships

of harmony. Such work, in effect, helps students to become more aware of that kind of language use and its power to create peace.

Language production, in terms of creative writing, is a central element of many language textbooks and provides another opportunity to explore peace. Focusing on ideas of peace – and on using the vocabulary of peace even as the causes of its loss may be part of the narrative – does lead to transformative experiences. Novels such as Leo Tolstoy's *War and Peace*, Ian McEwan's *Atonement*, Alice Walker's *The Color Purple*, Michael Ondaatje's *The English Patient* or Toni Morrison's *Beloved* elicit cathartic responses from their readers. This is equally true of other literary forms, such as poetry and drama. Such artistic 'works of peace' help contribute to a peaceful world through their lyrics, imagery and language devices. And as students are given exercises to analyze these works of art, they too engage through language with the making of peaceful societies.

Language textbooks can make use of discourse analysis for the promotion of peace. Media discourse exercises can reveal how language can be used for peace or for violence. Such an analysis of media will include the examination of the type of headlines used, the various news stories included, their diction, structure, use of figurative language, the production of stereotypes, the biases, assumptions, facts included or omitted to determine the overarching purpose of the discourse for peace or non-peace. Such analysis reveals language use in determining attitudes to different groups of people and nations. The use of language to marginalize societies and people has been discussed in section 1. Activities and exercises on unpacking the production of marginality and stereotypes, for example, can lead to a greater understanding of the reasons for conflicts between people and ways to address these. Discourse analysis, with its emphasis on higher-order thinking, listening, reading, comprehending and writing skills, is a tool for understanding language's role in producing as well as preventing violence.

Later in this chapter, the example of a unit on peace and conflict illustrates various ways in which language textbook writers can create a unit on peace. The activities include listening and responding to songs about peace. It is hoped that the repetition of words of peace will encourage students to interact harmoniously with one another. Recognizing that peace can break down when there are opposing views, there is a debating exercise to help students find the appropriate language to express disagreement with each other. Also included is a tool for managing conflict through dialogue: restorative justice circles. This is being used with success in many schools as well as in communities in different countries. (For more ideas about using language for peace, see also the Literature for Peace Project at Mico Teachers' college in UNESCO's *Guidelines and Recommendations for Reorienting Teacher Education for Sustainability*.)

<sup>6</sup>Available at <http://ohpi.org.au/>

## 3.2.6

## Using language for social justice

Here we begin by considering the relationship between social justice and ESD and will then explore how language can be used for social justice. Social justice – the practising of beliefs and policies – forms the basis of the work of ESD. The presumed authority and truth of any approach to curriculum and instruction in public education is always provisional, historically situated, contextual and political, rather than fixed, stable, universal or neutral. This may be especially true when making policies for socially just purposes or intentions, as is the case when crafting texts that address issues of inequity for students. Stakeholders must learn to treat representations of policy and practice as provisional and ever-evolving, depending on context. They must periodically re-examine findings and implementation to ensure policies and practices continue to align to the values of ESD. Doing so prevents processes of rational policy decision-making from creating unintended pitfalls and negative consequences that are common even when unintended and unpredicted. In other words, social justice work is mired in a web of constant surveillance that, while it is social-action and change oriented, it can also be contentious. It is important to recognize that any lesson can remain adaptive across contexts to optimize student success.

Textbook authors are mapping out work for teachers and learners that situates social justice as the fulcrum for peace, equity and sustainability. It is of critical import that such work entails equity-

oriented lessons to enhance student efficacy, engagement, motivation and achievement. By recognizing that social justice is part and parcel of ESD, textbook authors will pay explicit attention and respect to social, cultural, economic, historical and environmental issues specific but not limited to matters of race, ethnicity, gender, gender expression, age, appearance, ability, national origin, language, spiritual belief, size (height and/or weight), sexual orientation, social class, economic circumstance, culture and the treatment of animals (CEE, 2009, belief 2, paragraph 3).

Textbook authors can provide call-out boxes, notes and lists that define social justice and provide designs that are responsive to learners in ways that are socially just. As demonstrated in Table 1 (overleaf), textbook authors need to be aware that responsive teaching for social justice requires an approach that (at least) brackets professionals' personal beliefs/ideologies in favour of knowledge-based and socially just teaching practices that are known to maximize equity for each student as well as correlate with increased success (Burns and Botzakis, 2016). Treated in this light, bracketing is a professional technique that can expand educators' knowledge of self and other. As such, textbook exercises should reflect this. Textbook authors also need to be aware that the theory of social justice (Miller and Kirkland, 2010) comprises three key elements: reflection, change and participation.

Language for social justice can be addressed through myriad categories. Table 1 addresses the possible topics for teachers and outlines how to select texts that address them.

*Textbook authors are mapping out work for teachers and learners that situates social justice as the fulcrum for peace, equity and sustainability. It is of critical import that such work entails equity-oriented lessons to enhance student efficacy, engagement, motivation and achievement*

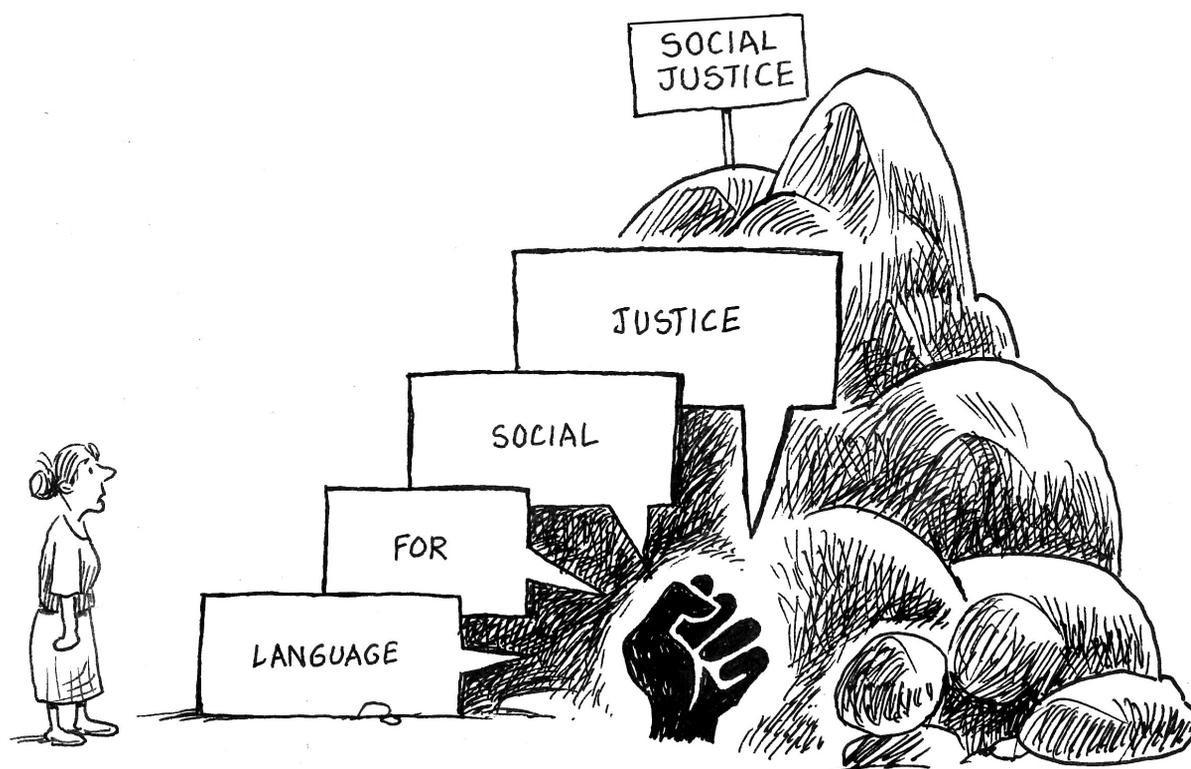


Table 1: Language topics suited to the inclusion of social justice

LANGUAGE TOPIC	EXPLANATION	EXAMPLE
<p><b>Hurtful words/ bullying</b></p>	<p>Each context has offensive words that are derogatory and hurtful. Select examples of those words, look at their etymology and unpack the connotations in order to understand how they can be unjust.</p>	<p>The 'N word' in the US can be considered offensive to people of colour depending on the context and the speaker.</p>
<p><b>Pronoun use</b></p>	<p>Each context has different pronouns used or not used to represent gender. Not all people identify with a gender or with the gender they are perceived to be. Review the pronouns used in various contexts and consider how they position identity.</p>	<p>The pronoun 'they' is used in the US as singular so gender is not presumed.</p> <p>For instance: 'They were going to the bathroom,' or 'I don't know what they were doing.' In these cases 'they' is considered first person and not plural.</p>
<p><b>Gender, positioning and norms</b></p>	<p>Each context has historical and current norms related to gender, gender expression, gender roles and gender identities. Beliefs and their reinforcement affect the way people 'see' and 'understand' gender. These beliefs then presume that people have to dress, behave and even respond in ways that align with social mores. These beliefs create stressors that can affect people's psycho-social-emotional well-being.</p>	<p>Understand that gender intersects with other identities (e.g. culture, language, age, religion, social class, body type, accent, height, ability, disability and national origin) that inform beliefs and, thereby, actions.</p> <p>Understand gender as flexible and be mindful of how specific discourse(s) can reinforce gender norms. Demonstrate purposefully how gender is fluid or exists on a continuum, shifting over time and in different contexts.</p> <p>(See Appendix 2. For more examples see Miller, 2015a, b; 2016.)</p>

<b>SOCIAL JUSTICE STEPS</b> (accounting for reflection, change and participation – Miller and Kirkland, 2010)	<b>HOW TO SELECT TEXTS</b>
<p>Create a lesson about ways to manifest language justice, which asks students to identify loaded and hurtful language used by them, against them and directed at others. Ask them to do research on terms (e.g. with people and in texts), review the etymology and understand the social, emotional and affective impact. Ask them to consider solutions to reduce, reframe and/or disrupt the use of those terms.</p>	<p>Generate a list of texts and websites across a range of genres (poetry, short stories, plays, novels, young adult novels, music, art, etc.) that include hurtful and offensive language and are intended to minimize someone. Be sure these texts also address forms of healing, redemption and change. Some of these texts can be embedded within a teacher's culture or they can be examples from other cultures.</p> <p>Examples of such books for teenagers include <i>To Kill a Mockingbird</i> by Harper Lee; <i>Every Day</i> by David Levithan; <i>The Color Purple</i> by Alice Walker.</p> <p>These websites have excellent resources:  <a href="http://www.bulliesinbooks.com">www.bulliesinbooks.com</a>  <a href="http://www.sjmiller.info/young-adult-literature.html">www.sjmiller.info/young-adult-literature.html</a>  <a href="http://www.nancykeane.com">www.nancykeane.com</a></p>
<p>Create a lesson about ways to manifest pronoun justice, which asks students to identify pronoun use (or lack of) in their school, local community and state/country. Ask them to research the terms (e.g. who is named and who isn't, how they differ by context and gender or lack of). Ask them to consider how pronouns can marginalize some people and work with them to develop strategies for challenging and changing beliefs (e.g. talking to teachers about how they want to be named/called), practices (e.g. posters in classrooms and on school walls, campaigns in the local community) and policies (e.g. school codes, health care forms and school letters).</p>	<p>Generate a list of texts and websites across a range of genres (poetry, short stories, plays, novels, young adult novels, music, art, etc.) that take up pronoun use in various cultures.</p> <p>Examples of these texts for teenagers include <i>I am J</i> by Cris Beam; <i>Brooklyn, Burning</i> by Steve Brezenoff; <i>Beyond Magenta: Transgender Teens Speak Out</i> by Susan Kuklin, <i>Annabel</i> by Kathleen Winter.</p> <p>These websites have excellent resources:  <a href="http://www.goodreads.com/shelf/show/gender-identity">www.goodreads.com/shelf/show/gender-identity</a>  <a href="http://www.huffingtonpost.com/em-and-lo/the-21-best-transgender-b_b_9702762.html">www.huffingtonpost.com/em-and-lo/the-21-best-transgender-b_b_9702762.html</a></p>
<p>Create a lesson about ways to manifest gender justice that asks students to understand how gender expectations position people to behave and perform in ways that may counter how they identify themselves. Ask them to make observations in their school, local and national/state communities (e.g. first, about themselves in school – their class, sports teams, academic groups – then in the media, at home, in different jobs, etc.) about how gendered expectations can lead to negative social and emotionally affective consequences. Work with students to develop strategies for changing beliefs (e.g. talking to teachers and others about how they want to be named/called), practices (e.g. incorporating texts that challenge and advance gender expectations) and policies (e.g., working to develop strategies to help build gender justice/equity in pay, academic opportunities, treatment and in the law).</p>	<p>Generate a list of texts and websites across a range of genres (poetry, short stories, plays, novels, young adult novels, music, art, etc.) that take up gender, gender roles and norms in various cultures.</p> <p>Examples of these texts for teenagers include <i>The Servant</i> by Fatima Sharafeddine, <i>The Perks of Being a Wallflower</i> by Stephen Chbosky, <i>The Boy in the Dress</i> by David Walliams, <i>The Outsiders</i> by S.E. Hinton.</p> <p>These websites have excellent resources:  <a href="http://www.noodle.com/articles/10-young-adult-books-that-defy-gender-stereotypes">www.noodle.com/articles/10-young-adult-books-that-defy-gender-stereotypes</a>  <a href="http://www.goodreads.com/shelf/show/gender-roles">www.goodreads.com/shelf/show/gender-roles</a>  <a href="http://www.questia.com/library/literature/literary-themes-and-topics/gender-roles-in-literature">www.questia.com/library/literature/literary-themes-and-topics/gender-roles-in-literature</a></p>

**Box 2****Possible genres to include in textbooks**

- Using different textual genres can help address the issues of injustice set out in Table 1. Each context will have examples of required and selected texts that will lend themselves to this work. Teachers can choose from a variety of resources or even have students create their own materials.
- You can include poetry, music, art, comics, tattoos, emojis, text messages, short stories, plays, books, TV, movies, podcasts, videos, audio books, etc.
- Select texts that address the areas in Table 1 – or even ones that do not – and apply critical literacy to deconstruct and unpack language topics.

The work of social justice encourages us to look closely at the conditions that have structured the system that reinforces beliefs, practices and policies and that can then inform the identities of our young people. As we come to work more intently and review how injustices in different environments can lead to hurtful outcomes, ESD can help establish more fair and equitable schooling and social and cultural environments. This work must look at root causes, ways to change the exclusionary political, economic and affective practices and the subsequent conditions that have created injustice in the first place. To transform schools and educational systems, we must peer deeply into the conditions in which language structures were created and then interlocked with policies, beliefs and behaviour related to power, privilege and identity. For genuine change to occur, we have to shift the conditions that continue to maintain structural inequities that affect today's schooling environments and that can inflict pain and trauma on our young people. By shifting conditions, we change outcomes and can create fair and just contexts.

**3.2.7****Language for advocacy**

*To create a society that is peaceful and just, students need to learn how to advocate for this. Much of the work towards achieving the goals of sustainable development requires advocating for policy and action*

To create a society that is peaceful and just, students need to learn how to advocate for this. Much of the work of enabling the achievement of the goals of sustainable development requires advocating for policy and action. As students acquire knowledge, develop attitudes, values and thinking skills for sustainability, they need also to be enabled to act on national and global policy levels.

Specifically, they need to learn the skills of advocacy. The teaching of English provides an ample platform for this because it aims to develop students' communication skills – informing, persuading, clarifying and narrating. Textbook writers can facilitate this by ensuring that the usual topic on argument includes the 'big sustainable development purpose'. For the planet's sake, students need to learn the art of persuasion to have others understand that the Earth is threatened and that people can change the situation. The urgency of changing hearts and minds for a better world requires textbook exercises and activities that relate closely to local and global issues by identifying authentic and real-world tasks and materials.

In preparing students to use language as a tool for advocacy, textbook authors should consider exercises that emphasize the importance of what they need to advocate for, what to express strong feelings for, who the target audience is, the local and international agencies or agents to speak to,



the type of language to be used (including tone and diction). In the example 'my community' later in this chapter, we suggest a language advocacy activity in which students write to their political representative, councillor or any authority figure for their area on a sustainability issue they have identified.

In reflecting on using language as a tool for advocacy, we are also mindful of the socio-linguistic skills that are part of this use. Textbook writers could include activities that require learners to engage in dialogue with respect, to listen actively and accurately and to speak or write with a clear purpose for public benefit. Exercises that highlight process and challenges are also important. A good advocate will need to understand the process and challenges of effective communication. Textbooks should also include exercises on developing language skills that will focus on clarity of thought, expression and style as well as discourse knowledge (perhaps the language and procedures of the courtroom).

The language of advocacy can be addressed through:

1. ARGUMENT – the logical and clear presentation of evidence and justifications to support a point of view.
2. AFFECT – assertiveness on one hand and respect and open-mindedness on the other.
3. STYLE – linguistic choices that add interest, emphasize and reinforce key ideas and thus make an impact on the audience.

In the second example module, 'peace and conflict', a debating task demonstrates how learners' attention can be drawn to these strands of the language of advocacy. As their awareness of these communicative skills is raised, not only will learners be able to play an active part in advocating for sustainable development and peace, but their sensitivity to how these techniques may be skilfully adopted to promote non-violence, justice and respect for our environment will be heightened.

*The mother tongue can be used as a resource in the English language classroom instead of being treated as an 'interloper'. Practically, this implies orienting textbooks to promote such multilingual activity*

### 3.2.8

## Developing language as a tool for identity through mother-tongue use

As indicated in section 1, there is a growing concern about the hegemony of English in relation to other languages, particularly the mother tongues of school students, given that language and culture are closely linked. Modi (2010) and Durairajan (2005) highlight the social stigma associated with speaking the mother tongue – as well as English that 'betrays' an influence of the mother tongue – in schools that use English as the medium of instruction.

The 2014 report on *The Promotion and Use of Local Languages in Primary Education in Senegal* states that when learning at school takes place in a language that is different from that spoken at home, there is a symbolic break for the student 'between the two major institutions of socialization, which are the school and the family'. Skutnabb-Kangas (2002), who

has published widely on linguistic human rights, has argued that the learning of a new language, including a *lingua franca*, ought to be additive rather than subtractive and, therefore, not done 'at the cost of diverse mother tongues'. This recommendation is particularly relevant in the context of the global refugee crisis that has given rise to new challenges for language education, with the student population becoming more linguistically diverse. As indicated in the *Position Paper of the National Focus Group on the Teaching of English in India* (NCERT, 2006), the mother tongue can be used as a resource in the English language classroom instead of being treated as an 'interloper'. Practically, this implies orienting textbooks to promote such multilingual activity.

The National Focus Group paper advocates that, at the lower primary stage, which is taken to be Classes 1 to 3: 'English can occur in tandem with the first language(s) for learning activities designed to create awareness of the world around the child.' It suggests doing away with 'linguistic purism, whether of English or of Indian languages', and moving towards 'a tolerance of code-switching and code-mixing, if



necessary'. This is in keeping with the idea that multilingualism should be viewed as 'one of the most important goals in education' (Skutnabb-Kangas, 2002) so students from dominant group populations have the opportunity to learn other languages well, and students from indigenous and minority group populations do not have to face 'linguistic genocide'.

Sagar and Rehman (2011) recognize linguistic diversity as 'vital for the long-term survival of humanity' because it involves building bridges across race, culture and other identities. This is essential for achieving Sustainable Development Goal 4.7, which emphasizes the 'promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development'.

Specific strategies to invite the mother tongue into the English-language classroom through textbooks include:

- i. Selecting short texts from works of post-modern and post-colonial fiction in English that celebrate borrowing words from other languages. For example, the novels of Chinua Achebe, Moni Mohsin, Vikram Seth, Salman Rushdie and Amitav Ghosh.
- ii. Selecting excerpts from texts translated into English from other languages to encourage an appreciation for diverse cultures depicted in the stories. For example, the novels of Gabriel García Márquez, Elena Ferrante, Yasunari Kawabata, Aleksandr Pushkin and Ambai and the poems of Pablo Neruda, Mawlana Jalaluddin Rumi, Faiz Ahmed Faiz and Mahmoud Darwish.
- iii. Including vocabulary-related activities that require students to focus on specific words in a text and asking them: 'How do you say this in your home language?' (Particularly vocabulary related to the weather, the names of fruits, vegetables and animals.)
- iv. Drawing attention to English words in the textbook that originate from other languages, for example, words such as juggernaut, rendezvous, brouhaha, boondocks, karaoke, catamaran, etc.
- v. Selecting texts that highlight the beauty, complexity and anxiety associated with linguistic diversity. For example: Arundhati Subramaniam's poem *To the Welsh Critic Who Doesn't Find Me Identifiably Indian* and Kamala Das's poem *An Introduction*.

*Literature, in effect, adds another dimension to language teaching and learning, interpretation and thinking skills. Equally important, students can learn, through literature, to identify multiple perspectives on a subject as well as the perspectives and values needed for a sustainable world*

### 3.3

## Use literature/language to enable learners to make informed decisions and take action as responsible global citizens

### Principle 3

In discussing this principle, we look at the following aspects:

- Developing interpretation and thinking skills.
- Reading ecocritically.
- Clarifying values.
- Developing empathy and taking varying perspectives, including a future's perspective.

In Principle 2 we emphasized the importance of selecting the appropriate content and identifying the skills to be promoted in language textbooks. We also need, however, to consider another area of language – reading. Principle 3 focuses on engagement, not so much through literacy and reading comprehension but with literature, which encompasses literacy and comprehension and extends them in various ways. A number of language texts recognize the importance of literature and incorporate this by using extracts from novels and plays or reproducing whole texts of poetry and short stories.

Literature, in effect, adds another dimension to language teaching and learning, interpretation and thinking skills. Equally important, students can learn, through literature, to identify multiple perspectives on a subject as well as the perspectives and values needed for a sustainable world. Moreover, students can learn to develop empathy – to 'walk in another's shoes' – a necessary ability if human beings are to live well with each other, to respect and care for each other and the planet. Literature can be used in language textbooks to deepen students' understanding of their world and, in particular, the values needed to preserve it.

### 3.3.1

## Developing critical interpretation and thinking skills

In looking at Principle 2, we discussed ways in which critical thinking skills could be developed. We extend that by looking at skills of interpretation.

Students need to understand the reasons for varied and sometimes contrasting interpretations. This will help them to appreciate divergent views while at the same time learning to discern the ‘truth’ of a text – its meaning.

A useful exercise to enable the development of interpretation and thinking skills is to have students reflect on the process of interpretation. This exercise, perhaps in the form of a flow chart, would have students note the importance of the reader in the process (their context, their knowledge) as well as the text itself (its context, form and language, for example, the use of words at the denotative and connotative levels, the choice of words, the structure). Another exercise could ask students to identify what they did as they interpreted an extract from a literary text and what led to their specific interpretation.

### 3.3.2

## Reading ecocritically

Textbook writers can also help learners attend to the physical environment even when the material does not focus directly on environmental issues. Learners can be taught a particular kind of reading that will uncover the sustainability frame. Here we see the value of ecocritical theories and reading. Ecocritical reading, simply explained, is to interpret literary texts (prose fiction, poetry and drama) by focusing on the environment and humans’ relationship to it and how such relationships have social and economic implications. This kind of interpretive work is a way of infusing ESD and enabling the understanding of sustainable development issues. This approach is particularly apt when we consider the point made by Orr (2004) that all education is environmental education and that learning spaces, pedagogical approaches and disciplinary boundaries, as well as the curriculum, need to be shaped by the attention to place.

Textbook writers can develop students’ sensitivity to and appreciation of the environment – foundational to their learning to respect, conserve and protect the planet. One way is through activities that require students to respond critically to extracts from literature texts that describe the environment, as well as to photographs of different landscapes. Specifically, students can be asked to examine how the environment is represented, the characters’ attitudes to these representations and the relation between the physical environment and the social and economic context. The aim is to focus the students on the physical environment in texts so they do not just see it as a setting or context but as a subject in its own right. Textbook writers can also enable students to have a deeper reading of the environment by paying greater attention to the writer’s use of metaphorical language, structure and tone in representing it.

Some fiction, for example, Octavia E. Butler’s science fiction novel *Parable of the Sower*, explores fully the environmental, social and economic crisis we face today. Employing a future’s perspective, Butler helps us ‘see’ very closely a world disintegrating as it has failed to address sustainability issues such as climate change. She exposes the inter-relatedness of the social, economic and environmental aspects of society. Language textbooks with a sustainability lens, will, therefore, ensure that the activities and tasks selected will include exploration of extracts from novels like this. They could be from the science fiction genre but not exclusively so. There many other literary texts with a sustainability/environmental focus, such as novels by Margaret Atwood, Barbara Kingsolver and Leslie Marmon Silko. They will help students to explore themes in a holistic way so they are able to recognize the connections between the social, the economic, the political and the environmental. In other words, they are taught to see the ‘big picture’ and they learn to think futuristically.

The following tasks, which focus on an extract from *Flight Behaviour* by Barbara Kingsolver, illustrate this deeper reading of the environment.

#### Novel extract

*The tree was intact, not cut or broken by the wind. What a waste. After maybe centuries of survival it had simply let go of the ground, the wide fist of its root mass ripped up and resting naked above a clay gash in the wooded mountainside. Like herself, it just seemed to have come loose from its station in life. After so much rain upon rain this was happening all over the county, she’d seen it in the paper, massive trees keeling over in the night to ravage a family’s roofline or flatten the car in the drive.*

(Flight Behaviour, p. 6)

Close textual analysis would include studying the various contrasts, the dominant image of the tree, the mountainside and other language and literary devices. Students could also be asked to locate the broader context of extreme weather conditions and climate change and to identify the feelings – and possible reasons for them – that the passage evokes. Questions could include: what are the possible reasons for the extreme weather conditions? How do the characters respond? What can be done in light of such events? Other activities could include contrasting literary descriptions such as the one above with extracts from science or geography describing a similar phenomenon. Questions could include: what is gained in each description? What is lost? What is the writer making us see, understand and feel? What action can we take?

*Ecocritical reading interprets literary texts by focusing on the environment and human beings’ relationships with it. In doing so, it considers the social and economic implications of such relationships*



Values clarification needs to be linked to cultural context. Diverse communities do not all share the same values. Since textbook writers are often writing for diverse groups, some attention has to be paid to different value systems. One useful way of addressing this is by having students examine the *Earth Charter*, which sets out a common set of values for the planet.

Activities based on dialogues can help students identify and clarify values. A close reading of dialogues in literature texts would provide a space for this. In addition, students could be asked to analyze or create sets of dialogues to explore values. Students could also be asked to engage in dialogue on a subject or with individuals who have differing opinions (after having been given appropriate guidelines). In this way, they are engaging in concrete transformative activities in the classroom.

Noddings (2002, p. 17) indicates how this may be done, advocating a dialogue in which participants

take turns as carer and cared-for and reach across ideological gaps to connect with each other.

Noddings (2002, p. 18) also cites the Common Ground Organization as illustrating how to put aside the 'war model of dialogue'. She describes an organization in which women on opposite sides of the abortion issue engage in 'true' dialogue. Their goal is not to persuade opponents to agree with them but 'to maintain caring relations across difference' so communication, compassion and empathy are nurtured. The violence and name-calling are being addressed in practical ways. The women, furthermore, have found common ground where they can achieve common goals, for example, by providing help to children in need. Most important, they model a way to live constructively with differences. Translating that into a textbook lesson would go a long way in developing the peaceful societies we wish for. An exercise requiring students to identify contrasting and competing values, followed by a search for common goals and common ground, would, therefore, be valuable.

*Literature provides many different experiences for our students as well as providing opportunities for exploring many different perspectives. By reading literature, students can become immersed in the lives of others, experience their pain and joy and view subjects from different points of view*

### 3.3.4

## Using literature to develop empathy and the ability to see varying perspectives, including a future's perspective

Equally important is the use of literature for developing empathy – helping students to see the world from the perspective of other people and to experience how others feel. Literature provides many different experiences for our students as well as providing opportunities for exploring many different perspectives. By reading literature, students can become immersed in the lives of others, experience their pain and joy and view subjects from different points of view. Literature becomes a means of building connectivity between people and animals.

For example, in the 1995 US film *Powder*, the eponymous hero impels a hunter to rethink his wanton killing of animals. Acting as a conduit, Powder makes the hunter experience viscerally the death pangs of the beautiful deer he has shot for sport. A good literary text will also make that kind of impact on its readers. By using literature, textbook writers can create exercises that help students connect deeply with life. One way to do this is to have the students compare the text in the class with a similar real-world text. An example of this is provided in the 'Literature to Address Violence' case study in the UNESCO publication *Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability* (2005).<sup>7</sup>

Additionally, textbook writers can provide activities that help students to reflect on their feelings for different characters and situations, identify different worldviews and perspectives (as presented in the literature extract or text) and then discuss these in comparison with a sustainable development worldview.

### Box 3

#### The 'what if?' activity

- What if world leaders fail to honour climate action agreements?
- What would a newspaper produced 50 years from now look like if we honoured the climate action agreements? Consider its lead stories, commentaries, entertainment and comic sections.

Having a future's perspective or future-casting is a way of imagining what existing trends, attitudes and values could become. Useful language-textbook activities to explore future-casting could include students writing and exploring alternative futures and reading literature, such as the science fiction texts mentioned earlier, to analyze the possible futures presented.

<sup>7</sup>Available at <http://unesdoc.unesco.org/images/0014/001433/143370e.pdf>

## 4.0

## Examples

## 4.1

### Methods for embedding ESD in language textbooks

An ESD pedagogy emphasizes an action-oriented teaching and learning approach. Students are engaged in authentic tasks with their local and global community in mind. Language teaching is a way to bring attention to an issue and to produce change. Therefore, it is important to include some form of community action as an activity. This is seen in the following example of the unit 'my community'. In the second example, which looks at a unit on peace and conflict, the students engage in real-world action through a restorative justice circle. This gives them the opportunity to resolve their issues (perhaps conflict with other students) in a peaceful way.

*An ESD pedagogy emphasizes an action-oriented teaching and learning approach. Students are engaged in authentic tasks with their local and global community in mind. Language teaching is a way to bring attention to an issue and to produce change*

Student-centred as well as community-centred learning approaches are also encouraged. In this regard, project-based learning, participative, experimental and reflexive-based approaches are part of the toolkit for student-centred and community-centred pedagogy. In considering this, language textbook authors can ensure that the activities they write reflect this pedagogy. The Sandwatch programme, which is used by many schools around the world, provides another example of a community-centred and student-centred learning approach. In this programme, students are invited to monitor a beach or waterway for a period – noting such things as water quality, debris and beach erosion – and then analyze the results. The students then share their results and take action. Following this pattern, language activities could invite students to monitor an area to observe what happens there in terms of people's language interaction. They will then analyze it (for example, its content, type, the values reflected), share their findings (using different types of writing/media) and take action. This could include writing a newspaper article, preparing a poster that would help develop citizens' awareness of their language use and the values that are reflected. Of course, the Sandwatch programme could also be used as it stands to provide an opportunity to develop

different types of writing – expository, narrative and persuasive yet with an added advocacy element that includes the community more directly.

## Box 4

#### Approaches

- Action oriented
- Community centred
- Participatory
- Using real-world-focused tasks and materials
- Project based
- Experiential
- Reflective

Language with ESD embedded adds value to language texts, extending the work that language teachers and textbook writers are doing as they respond to the vision of a sustainable world. The examples below include the competencies to be developed and the specific language tools required as well as the activities.

## 4.2

### Example of a language textbook exercise with ESD embedded

## My community

In this textbook example for primary school pupils, we look at the topic 'my community'. The aim is to help students see what is happening in their community from a sustainable development perspective. They are, therefore, expected to identify aspects of the community that help to make it sustainable and aspects that do not. At a fundamental level, the learners will learn to appreciate and care for

their community as well as learn to take action to improve it. This will enable the learners to help make Sustainable Development Goal 11 achievable. (Goal 11 is to make cities and human settlements inclusive, safe, resilient and sustainable. The local issues are developing community awareness, peace-making, safety and caring for animals in the environment.)

In this exercise, language is being used as a tool for:

1. Communicating with clarity and with respect, for learning to listen actively, to think, speak and write clearly and coherently.
2. Critical thinking and interpretation.
3. Connecting with the community through real-world tasks.
4. Clarifying values.
5. Advocacy.

The specific language skills focus on writing – to describe accurately and with a purpose, to reflect and inform, to identify and clarify.

This is an example of a textbook module that can be used to help primary-level learners develop an appreciation for their local community, engage with sustainability issues and participate in the creation of sustainable societies through learning English. The module aims to develop a sensitivity towards what

it means to be a good citizen at the local as well as global level.

The objectives for English learning in this unit are broad based as well as specific. They include developing particular attitudes and values, such as learning to communicate with clarity and respect. They are also specific linguistic aspects because the unit seeks to address accurate standard English usage, for example, the correct use of tenses.

## ACTIVITY 1

### Listening to songs or a poem about communities

The first set of tasks or activities aims to help students see what is happening in their community from a ESD perspective, to learn to appreciate and care for a place and to think reflectively and critically about their communities. These tasks require the children to listen to songs about communities, for example, *Penny Lane*<sup>8</sup> by the Beatles and a Jamaican folk song *Linstead Market*; read reflective pieces on an interesting place in their community; visit local places of interest and watch video clips on zoos and game reserves. The songs selected reflect a love of community – a necessary attribute for learners if they are to develop as citizens who are aware of sustainable development practices.

An example of specific tasks learners would be required to carry out in connection with *Penny Lane*:

- Identify what is special to the singers about *Penny Lane*.
- Identify two or three lines with which you agree or which puzzle you. Explain why.
- Compose a response to the song.
- Choose a song (folk, pop, hip-hop, rap, etc.) that reflects your point of view on places special to you.

This second task uses a folk song from a region, which is intended to engender feelings of affection for a place. This Jamaican folk song can easily be substituted for one pertinent to another region.

#### Linstead Market<sup>9</sup>

*Mi carry mi ackee go a Linstead Market  
Not a quattie worth sell  
Mi carry me ackee go a Linstead Market  
Not a quattie worth sell  
Lawd what night, not a bite  
What a Saturday night  
Lawd what a night not a bite  
What a Saturday night  
  
Everybody come feel up, feel up  
Not a quattie worth sell  
Everybody come feel up, feel up  
Not a quattie worth sell  
  
Lawd what night, not a bite  
What a Satiday night  
Lawd what a night not a bite  
What a Satiday night*

Learners could be asked to:

- Discuss what happens at Linstead Market. Identify reasons why the singer is urging her listeners to go to Linstead Market, note what she expects to do there and why her hopes are dashed. Learners could also be asked to think about the effect of the singer's experience. What does she expect to do there? Why are her hopes dashed? What do you think will be the effect of her experience there?
- Discuss the language used – its similarities and differences from standard English.

(Students could also be asked to explore poems about home, for example, *Madras*<sup>10</sup> by Arundhati Subramaniam.)

<sup>8</sup> Video available at [www.youtube.com/watch?v=S-rB0pHI9fU](http://www.youtube.com/watch?v=S-rB0pHI9fU) Lyrics available at [www.azlyrics.com/lyrics/beatles/pennylane.html](http://www.azlyrics.com/lyrics/beatles/pennylane.html)

<sup>9</sup> Audio available at [www.youtube.com/watch?v=ICstpeu4Oes](http://www.youtube.com/watch?v=ICstpeu4Oes)

<sup>10</sup> Available at [www.poetryinternationalweb.net/pi/site/poem/item/12085](http://www.poetryinternationalweb.net/pi/site/poem/item/12085)

## EXAMPLE

### My community

EXAMPLE  
My community

## ACTIVITY 2.a

### Reflecting on special places in my community – a place of peace

Students could be asked to:

- Identify places in their community where they feel a sense of peace.
- Visit some of these places and interview individuals they meet there.
- Read what a writer says about a place that is special to them.
- Write about a place that is special to them.

### The Pool of Nectar

by Chintan Modi

Harmandir Sahib, the Golden Temple in Amritsar, is a place like no other I have experienced before. It does something to me. Though it is always filled with hundreds, perhaps even thousands, of people, somehow, I feel like I am the only one around.

There is something magical about taking off my clothes and entering that sacred pool to stand neck-deep in water, face the shrine, and soak in that meditative moment made special by the devotional music that fills the air.

That primordial sense of surrender to the elements is both refreshing and humbling. In that moment, there is no baggage to be held, there are no fears to be exorcised, there is no work routine to get back to. It is just me, in my skin, feeling grateful for the miracle of being brought there. May all beings experience this gift of peace. (Modi 2015)



Source: Chintan Modi

Figure 2: The Golden Temple of Amritsar

**ACTIVITY 2.b****Reflecting on special places in my community  
– the zoo****EXAMPLE**  
**My community**

A zoo is selected for this example but it could easily be substituted for other places of interest. It capitalizes on the learners' interest in animals to build their appreciation of place and animals. This exercise can also be used to explore the value of care and respect for the environment. The zoo is both a 'disturbing' as well as a 'positive' place. Learners are invited to think critically about their environment – and what they would like to change about it.

First they are invited to read a reflective piece on a child's visit to the zoo; then they are asked to respond by completing the following tasks.

**A VISIT TO THE ZOO IN MY COMMUNITY**

I love visiting the zoo. You really get to see up close many different types of animals, birds and reptiles. I also feel sad sometimes when I visit the zoo because the animals are locked away in cages. The much-feared lion, behind bars, seems to have sad eyes in its huge head. This is so different from movies I've seen of lions in the wild. There they appear to be strong and majestic. I wonder if it is right to have such a creature locked into such a small space, such a cage. I know, though, that there are zoos where big animals such as lions, elephants and hippopotamus are able to roam for miles.

- **LIST QUESTIONS** you may have about the way people treat animals.
- **CREATE A POSTER** on how we should care for animals.
- **WATCH A CLIP** from the film *Happy Feet* and share your views.
- **THINK ABOUT** what you would like to change about zoos.

Figures 3 and 4: Hope Zoo, Jamaica



Figure 5 and 6: Game reserve, South Africa

EXAMPLE  
My community

## ACTIVITY 3

### Advocating for change in my community

ESD pedagogy also includes an action-oriented approach and this exercise is one that enables learners to engage in community action. The learners are also using language as a tool for clarifying values and for advocacy. The specific language skills involve writing – to describe accurately and with a purpose, to reflect and to inform, and to identify and to clarify.

#### EXAMPLE TASKS

- **MAPPING** their community. Learners are asked to draw a map on which they identify main streets and interesting places. They highlight positive places in their community (ones that bring joy and comfort) as well as troubling places that they would like to change.
- **WRITING** to their local councillor or leader advocating for change.

The learners could then be given guidelines for writing a letter of advocacy. They would be guided in terms of the content, that is, the language used (tone and diction) and how to communicate coherently with respect and clarity.

Suggested guidelines for writing a letter of advocacy could include asking learners to:

- i. **MAKE** a list of the problems in their community. For example, these could relate to issues of health (no piped water, too many mosquito-breeding grounds, garbage not collected on a regular basis) or violence (poor lighting, no security cameras, too many people with guns, too few police patrols).
- ii. **DECIDE** who they will write to, for example, the councillor or leader for the area.
- iii. **PLAN** what they will write. Make an outline.
- iv. **EXPLAIN** clearly the problem and its impact on the community's well-being.
- v. **ACKNOWLEDGE** what has been done already with regard to the problem. Request what they would like done. Indicate what they will contribute to solving the problem.
- vi. **BE RESPECTFUL**. Try to see the problem from other people's perspectives.

#### 4.3

#### Example of a language textbook exercise with ESD embedded

### Peace and conflict

This example textbook module targets junior high-school students and explores the theme of peace at an individual, national and global level. It makes use of the 'open content space' of language teaching to address complicated topics such as the value of war, national identity and conflict resolution. A variety of language tasks that use authentic fictional and non-fictional texts are included to help students develop the communicative competencies that allow them to analyze texts critically and systematically, empathise, reflect, advocate and act on their values.

A range of language teaching points is covered:

1. *For grammar* – active and passive voices.
2. *For vocabulary* – gender-biased expressions.
3. *For literary devices* – figures of speech such as puns.
4. Rhetorical strategies.

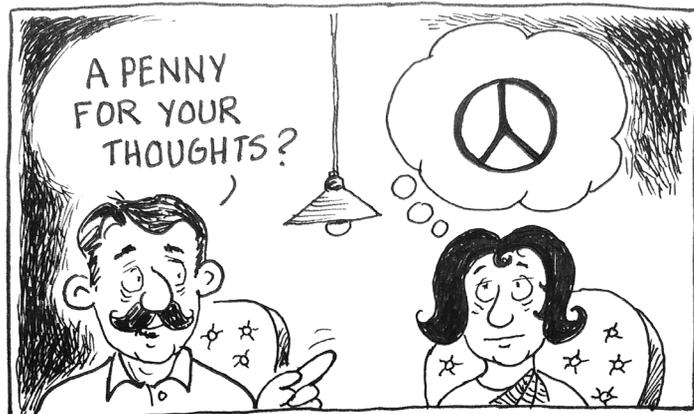
Rather than including these language teaching points in a standalone, non-communicative manner, they are blended into this thematic module with a strong ESD focus, making it a great example of how the 'open content space' allows language and ESD teaching objectives to be achieved simultaneously. In the first sample activity, students are asked to compare two songs about peace and war. Publishers could make use of any authentic songs, preferably based on or in response to historical events, to help

students see the relevance of the texts to their world. Authentic literary texts also often encourage further individual investigation of the historical context of the songs.

In this example, students are guided to empathize with the protagonist (Song 1) or the songwriter (Song 2), allowing them to understand a topic from other people's perspectives, develop the capacity to feel for other people and see how human experiences are connected.

Questions 1, 3 and 5 are follow-up tasks that ask students to select lines that resonate with or confuse them and rewrite lyrics of another song to show their feelings. These provide opportunities to respond to the empathy felt in the previous task.

Students' attention can also be easily drawn to the use of language to promote peace and justice in the selected texts. The given example discusses how grammatical structures, such as active and passive voices, are used to highlight or hide the agent of an action (question 4). For vocabulary, awareness of gender-normed phrases, such as 'brotherhood' in question 7, is raised. Literary devices such as puns that require inferential reading (question 2) are introduced.



## ACTIVITY 1

### Comparing two songs that reflect on peace and conflict

#### EXAMPLE

#### Peace and conflict

Listen to the two songs below. Read the lyrics and answer the questions.

**Song 1:** *Buffalo Soldier* by Bob Marley<sup>11</sup>

1. Why do you think the buffalo soldier was 'fighting on arrival' and 'fighting for survival'? How do you think he felt about this?
2. The phrase 'where you're coming from' is used as a pun, i.e. an expression with multiple meanings. What could this phrase refer to here?
3. If you were a buffalo soldier, who would you consider yourself to be or where would you belong?
4. Are the verbs (the words 'win', 'fighting', 'driven') in the active or passive voice? What do the differences in voices help to emphasize? By using the passive voice, what information is the songwriter able to withhold from the audience?

**Song 2:** *Imagine* by John Lennon<sup>12</sup>

5. What reasons for killing and death are mentioned? Do you agree it is more likely for people to live in peace when these things do not exist?
6. Compare the two lines ('It isn't hard to do' and 'I wonder if you can?'). To the songwriter, what is more difficult to imagine: no possessions or no countries? Why?

<sup>11</sup>Audio with lyrics available at [www.youtube.com/watch?v=IEpSBsUjY-0](http://www.youtube.com/watch?v=IEpSBsUjY-0)

<sup>12</sup>Audio with lyrics available at [www.youtube.com/watch?v=RwUGSYDKUxU](http://www.youtube.com/watch?v=RwUGSYDKUxU)

7. What do you think the ‘brotherhood of man’ refers to? Why do you think John Lennon did not write ‘sisterhood of women’ instead? Do you agree with his choice of words?

1. **COMPARE** and contrast the two songs in terms of:

- The content.
- The perspectives of the songwriters.
- The language.

2. **IDENTIFY** two or three lines that resonate with or puzzle you. Explain why.

3. **CHOOSE** a song (pop, hip-hop, rap, etc.) and rewrite the lyrics so that they reflect your point of view on peace.

The second sample activity is a debate on a topic entitled ‘Is war ever justified?’ Debate is a popular language teaching activity because it requires students to consider different points of view carefully and to analyze their validity objectively. Students build arguments, identify and evaluate reasons and gather evidence to support their arguments, as well as refute opposing points of view. In the example below, guidance on argument is provided specifically in steps 1 and 2. Training like this promotes critical thinking skills and reinforces logic in persuasion.

Another learning focus for the debate could be peaceful and non-confrontational communication. (Specific strategies that language teachers can use are discussed by Modi in ‘Responding to conflict’ in *Teacher Plus* (2014a).<sup>13</sup>) Guidance can be given on verbal and non-verbal communication skills for showing disagreement respectfully. Our example below highlights language features that promote peaceful and rational communication, such as hedging and modality, and delivery skills that show assertiveness but non-aggression (steps 3 and 4). An example of how two professors hold a peaceful debate on a similar topic is shown to students (step 6).

Student-centredness is, naturally, another feature of a debating activity. To enhance this further, the outcome of the debate can be left to students to judge, as in this example.

This passes the authority to assess and evaluate from the teacher to the students, giving them a stronger sense of owning their learning.

<sup>13</sup>Available at [www.teacherplus.org/2014/november-2014/responding-to-conflict](http://www.teacherplus.org/2014/november-2014/responding-to-conflict)

**EXAMPLE**  
**Peace and conflict**

**ACTIVITY 2**  
**Debating the topic ‘Is war ever justified?’**

Some people believe wars can be justified, if certain conditions are met. Others believe that the damage caused by war outweighs any benefits it can bring in all circumstances. The ‘just war theory’ is debated widely by philosophers, theologians of different religions, military leaders and policy-makers alike.

You will participate in a debate on: ‘Is war ever justified?’

*Brainstorm*

1. In your group, brainstorm reasons why war can possibly be justified and why it can never be. You can use the table below to help your organize your ideas.

War can be justified	War can never be justified
because... /if...	because...

*Debate*

2. Your group will debate the topic against another group. You will draw lots to decide which group will debate ‘affirmative’ and which group ‘negative’.

To prepare for the debate, first you should get the content ready. Revisit the table, select the most plausible points and make a list of the arguments you can use in the debate. Pay attention to whether these arguments are logical and if there is any overlap between them. Rewrite accordingly. These carefully revised arguments will form the framework for your debate.

A list of arguments, however logical and valid, will not convince many people unless it is supported by evidence. Next, therefore, you should conduct research and find relevant examples, data and facts. Very often, it is the quality of the supporting evidence, rather than the validity of the arguments themselves, that make or break your debate.

Lastly, you should also organize and sequence your arguments and, when appropriate, highlight connections between ideas using signpost phrases to make your points easy for your audience to follow.

3. Based on the points you have brainstormed in step 1, speculate the arguments your opponent group will present and prepare your rebuttal (i.e. why the opponent's ideas are not valid or significant). When you rebut a point, you should first summarize the opponent's argument and then focus on showing the fallacy in their argument. Even when you are disagreeing with the other group, you should still remain respectful. Making personal attacks or rude criticisms would only undermine your rationality and weaken your stance. To show respect and remain polite as you disagree, you may find the following expressions helpful:

*Rebut*

*That **may be** so, but ...*

*That **might have been** the case once, but ...*

*Well, **maybe** they do, but ...*

*... **may be** right about ... but ...*

***Possibly** ... But the problem is ...*

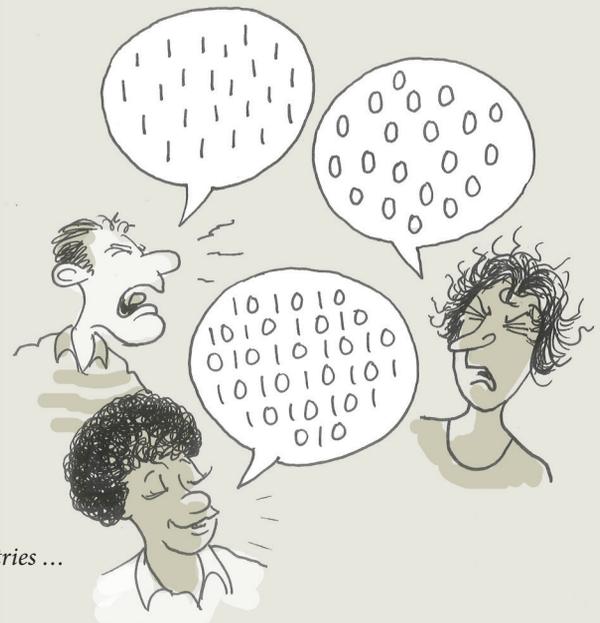
*That **would be** great, except that ...*

*That point of view **seems to be** logically irreconcilable.*

*While that **could be** true in some parts of the world ...*

*Although ..., ... **doesn't necessarily** follow.*

*That **appears to be** true in some parts of the world but in a lot of countries ...*



Did you notice what the **bold** words share in common? Do they show certainty or tentativeness? Why are they effective for showing disagreement politely?

4. Present your arguments. You should pay attention not only to the content of your arguments but also how you deliver them or, in other words, your non-verbal delivery. Think about how you may look and sound when you are firm and assertive, rather than aggressive and provocative.

*Present*

- Eye contact.
- Body language.
- Facial expressions.
- Voice.

5. After you finish your debate, discuss in your group:

*Discuss*

- Which group should win the debate.
- Which of your opponent group's arguments was the most convincing.
- Which member of your opponent group performed the best.

Remember to give reasons to support your choice. You can write a note or a text to show them your appreciation. The more specific your comments, the better.

Example: 'When you presented the argument about ..., the statistics you used were very persuasive. You must have done a lot of research into the topic. Well done!'

6. Professor Bryan Caplan and Professor Jan Ting once debated this topic on a television programme. As you watch their debate, make notes in the table below. Also notice how they remain peaceful and respectful, verbally and non-verbally, even when they disagree with each other.

*Watch*

Watch it here: [www.youtube.com/watch?v=Fmdf9kZG-2A](http://www.youtube.com/watch?v=Fmdf9kZG-2A)

Make notes below as you watch the debate.

IS WAR EVER JUSTIFIED?		
	Affirmative – Prof Bryan Caplan	Negative – Prof Jan Ting
<b>Argument 1</b>		
Supporting evidence		
<b>Argument 2</b>		
Supporting evidence		
<b>Rebuttal</b>		
Supporting evidence		

Compare your arguments and theirs. Notice how the professors build their arguments.

The third sample activity shows a practical and concrete way to teach students how to address conflicts, how to resolve their issues through dialogue, and how to build a trusting and caring community. (See Clifford's *Teaching Restorative Practices with Classroom Circles*.<sup>14</sup>) Note that restorative practice is also an alternative form of discipline to punishment.

The example below enables students to develop empathy but, this time, rather than empathizing with characters in a literary text, they will learn to communicate in order to feel for each other. Active listening can be promoted and with the clarification time built in, questions can be asked to help clear up any misunderstanding.

Using students' conflicts as topics of discussion, although potentially sensitive, gives the task authenticity and relevance when guided strategically by the steps and monitored by the teacher. When students themselves are the focus of a task, which is not always common in a classroom, they are likely to be a lot more engaged and motivated.

EXAMPLE  
Peace and  
conflict

### ACTIVITY 3

## Restorative practice in the classroom

Instructions on how to conduct restorative practice:

1. The teacher and the students sit in a circle.
2. The teacher explains the purpose of the activity (to address a particular issue or harmful behaviour, to build trust, to make things right) and the process.
3. The teacher and students agree on the rules for the circle – individuals listen to each other and speak only when they have been given 'the floor'. Participants use a 'talking piece', any object that the group deems appropriate, as a way of determining who is speaking. Participants speak only when they have the talking piece. The talking piece may be placed in the centre of the circle and picked up by anyone in the group who would like to speak. Once an individual has the talking piece, others in the group are to listen. The group also decides on the level of sharing and confidentiality.
4. The teacher uses prompt questions – to raise and clarify an issue, to encourage a respectful response. Keeps it real. Actively listens. Refrains from correcting and fixing. Uses and encourages use of the talking piece.

The teacher ends circle time and invites brief feedback from students. The teacher ends with a ritual, a practice that will become part of the classroom's routine.

<sup>14</sup>Available at [www.healthiersf.org/RestorativePractices/Resources/documents/RP%20Curriculum%20and%20Scripts%20and%20PowerPoints/Classroom%20Curriculum/Teaching%20Restorative%20Practices%20in%20the%20Classroom%207%20lesson%20Curriculum.pdf](http://www.healthiersf.org/RestorativePractices/Resources/documents/RP%20Curriculum%20and%20Scripts%20and%20PowerPoints/Classroom%20Curriculum/Teaching%20Restorative%20Practices%20in%20the%20Classroom%207%20lesson%20Curriculum.pdf)

## 5.0

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## APPENDIX 2

*The Queer Literacy Framework* (Miller, 2016), which is addressed to educators, may prove useful to textbook writers as they work to achieve an inclusive approach. Queer means a disrupting of binaries and a suspension of rigid categorizations of identity.

	Principles	Commitments of educators who use queer literacy
1.	Refrains from possible presumptions that students are heterosexual or ascribe to a gender.	Educators who use queer literacy never presume that students are a particular sexual orientation or a gender.
2.	Understands gender as a construct which has and continues to be impacted by intersecting factors (e.g. social, historical, material, cultural, economic, religious).	Educators who employ queer literacy are committed to classroom activities that actively push back against gender constructs and provide opportunities to explore, engage and understand how gender is constructed.
3.	Recognizes that masculinity and femininity constructs are assigned to gender norms and are situationally performed.	Educators who engage with queer literacy challenge gender norms and gender stereotypes and actively support students' various and multiple performances of gender.
4.	Understands gender and sexuality as flexible.	Educators who engage with queer literacy are mindful about how specific discourse(s) can reinforce gender and sexuality norms, and they purposefully demonstrate how gender and sexuality are fluid or exist on a continuum, shifting over time and in different contexts.
5.	Opens up spaces for students to self-define with chosen (a)genders, (a)sexuality, (a)pronouns or names.	Educators who engage with queer literacy invite students to self-define and/or reject a chosen or preferred gender, sexual orientation, name and/or pronoun.
6.	Engages in ongoing critique of how gender norms are reinforced in literature, media, technology, art, history, science, maths, etc.	Educators who use queer literacy provide ongoing and deep discussions about how society is gendered and primarily heterosexual, and thus invite students to actively engage in analysis of cultural texts and disciplinary discourses.
7.	Understands how Neoliberal principles reinforce and sustain compulsory heterosexism, which secures homophobia; how gendering secures bullying and transphobia; and how homonormativity placates a heterosexual political economy.	Educators who employ queer literacy understand and investigate structural oppression and how heterosexism sustains (a)gendered violence, and generate meaningful opportunities for students to become embodied change agents and to be proactive against, or to not engage in, bullying behaviour.
8.	Understands that (a)gender and (a)sexuality intersect with other identities (e.g. culture, language, age, religion, social class, body type, accent, height, ability, disability and national origin) that inform students' beliefs and, thereby, actions.	Educators who engage with queer literacy do not essentialize students' identities but recognize how intersections of culture, language, age, religion, social class, body type, accent, height, ability, disability and national origin inform students' beliefs and, thereby, actions.
9.	Advocates for equity across all categories of (a)gender and (a)sexuality orientations.	Educators who employ queer literacy do not privilege one belief or stance but advocate for equity across all categories of (a)gender and (a)sexuality orientations.
10.	Believes that students who identify on a continuum of gender and sexual minorities (GSM) deserve to learn in environments free of bullying and harassment.	Educators who use queer literacy make their positions known, when first hired, to students, teachers, administrators and school personnel and take a stance when any student is bullied or marginalized, whether explicitly or implicitly, for (a)gender or (a)sexuality orientation.



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Mahatma Gandhi Institute  
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and Sustainable Development

*'This guidebook will be an eye-opener for many stakeholders  
in curriculum and textbook development'*

Eckhardt Fuchs

Director, Georg Eckert Institute for International Textbook Research

The interconnected environmental, economic, social and political challenges facing humanity call for education that enables young people to engage creatively and responsibly with the world. More than ever, the quality of education is determined by whether students have access to content and pedagogy designed to help them learn to live together on a planet under pressure. In other words, education for sustainable development and global citizenship needs to become a core guiding principle of educational change. The United Nations' Sustainable Development Goal Target 4.7 offers the international consensus and momentum to achieve this.

Our proposal is to begin by taking the concrete step of transforming textbooks – the teaching and learning resources that are most prevalent around the world and the ones closest to students. This book offers concrete guidance for authors of mathematics, science, language and geography textbooks on how to 'embed' peace, sustainable development and global citizenship in textbook content. Embedding is not about inserting new thematic content into an already overcrowded curriculum. Instead, it is about reorienting core subjects to serve a purpose that is more socially and globally relevant, empowering young people to address local and global challenges with a shared respect for human dignity.

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