



The Role of Teamwork in the Creation of Open Educational Resources for Closing SDG-Related Knowledge Gaps

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ABSTRACT

The Sustainable Development Goals (SDGs) with their interconnected targets can only be achieved if their interactions are seriously taken into consideration. Education for sustainability is crucial for raising awareness of different stakeholders about the SDGs and their interactions. The paper discusses how teamwork creation of Open Educational Resources (OER), with their specific benefits, can contribute to closing knowledge gaps about the SDGs and their interactions. The example of OE4BW (Open Education for a Better World) international mentoring program and its energy-related hub, called the SDG7 Hub is presented and discussed, and its future development, targeting the creation of OER to close the SDG7-related knowledge gaps, is suggested. The resulting guidelines are generalized to provide a further increase of OER's contribution to the achievement of SDGs.

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INTRODUCTION

Adopted by the UN General Assembly in 2015, the Agenda 2030 (United Nations, 2021) represents a way of thinking about the global and long-term Sustainable Development Goals (SDGs), where the goals depend on each other, and their targets are interconnected. SDGs can only be achieved by raising awareness of different stakeholders and strengthening their understanding of the increased importance of all aspects of sustainability. This should be considered in formal education as well as in non-formal educational programs, activities and campaigns for various specific target groups and the empowerment of citizens in general. The paper discusses how teamwork creation of Open Educational Resources (OER) can support this process by contributing to closing the knowledge gaps about the SDGs and their interactions.

The role of Open Education and OER in achieving the SDGs has been recognised and broadly discussed (Levine, 2014; UNESCO, 2015; Mitter, 2016; McGreal, 2017; Lane, 2017; OECD, 2018; UNESCO, 2019; Fengchun et al., 2019; Atenas et al., 2020). The discussion on the effectiveness of the achievement of the SDGs has moved decisively towards the importance of understanding the SDG-related targets as part of a larger network and considering the interactions between the SDGs and the related knowledge gaps (Ison, 2010; LeBlanc, 2015; ICSU, 2017; Fonseca et al., 2020; Fortier, 2021). However, the existing theoretical and empirical research of the potential has not followed this focus yet. The SDGs interactions and the importance of closing the related knowledge gaps have not been explored from the specific perspective of OER (in general) and the potential contribution of teamwork created OER towards closing these gaps (in specific).

Several conceptual frameworks have been developed that map and/or score interactions of SDGs (e.g., LeBlanc, 2015; Nilsson et al., 2016; Fonseca, 2020) but there remains a lack of understanding of their importance from the perspective of education for sustainability that may foster more effective achievement of the SDGs' targets among different stakeholders, including the educational stakeholders, the policymakers and the citizens in general. UNESCO (2017) indicates that among the eight key competencies for education for sustainability are collaboration, integrated problem-solving and strategic competencies. These three competencies are closely in line with the benefits of OER, including collaborations and partnerships, knowledge sharing, and communication and community engagement (Bliss et al., 2013).

Therefore, it seems that OER may have a crucial role to play in strengthening the awareness about the SDGs interactions. The article explores this potential with a specific focus on energy-related issues. The presented study suggests an innovative teamwork approach for the collaborative creation of energy and climate related OER by taking into consideration the identified knowledge gaps in the interactions between SDG7 (Affordable and Clean Energy), SDG13 (Climate Action) and several other related SDGs.

The paper includes a case study of teamwork, implemented as a part of the OE4BW (Open Education for a Better World) program (OE4BW, 2021; Urbancic et al., 2019), an international online mentoring program designed to unlock the potential of OER in achieving the SDGs. In particular, the OE4BW energy-related SDG7 Hub is presented and discussed, and its future development, targeting the creation of OER to close the SDG-related knowledge gaps, is suggested to further increase OER's contribution to education for sustainability. However, the proposed approach is not restricted to its use in the OE4BW program and its topical hubs but can also be adapted and applied to other OER programs, projects and initiatives which aim at supporting the achievement of SDGs.

After describing the importance of understanding the interconnectedness of the SDGs and the conceptual frameworks that map and/or score the interactions among the goals and their targets, we focus on the key knowledge gaps in understanding the SDGs' interactions (section 2). Based on the authors' practical experience in SDG-related education and awareness-raising, we offer concrete examples of knowledge gaps between the SDG7 (Affordable and Clean Energy) and three other SDGs, namely SDG3 (Good health and well-being), SDG8 (Decent work and economic growth) and SDG13 (Climate action). The effectiveness of achieving the SDGs is then discussed from the viewpoint of closing these knowledge gaps and the key

competencies, needed for that, which are cross-linked with the benefits of OER (section 3). The benefits of OER related to the education for sustainability are then applied to a concrete example of teamwork, implemented for the OE4BW program and its topical hub on energy related OER, called the SDG7 Hub, established in 2019 (section 4). Based on the experience gathered in OE4BW's SDG7 Hub so far, innovative suggestions are offered on how to approach future OER development in a way that would best contribute to closing the SDG interactions-related knowledge gaps.

IDENTIFICATION OF KNOWLEDGE GAPS RELATED TO THE SDG INTERACTIONS, WITH A SPECIAL FOCUS ON SDG7

INTERACTIONS BETWEEN THE SDGS AND THEIR TARGETS

The 17 Sustainable Development Goals, SDGs, adopted by the United Nations in 2015 (United Nations (2021)), are an “indivisible whole” (Nilsson et al., 2016), a highly integrated web of interrelated challenges. We only succeed if we achieve all or at least most of the goals together by unlocking the power of systems thinking (Acaroglu, 2019) and by understanding the importance to support the development, sharing and efficient use of knowledge as the driving force in our economy and society (Urbancic, 2007).

Le Blanc (2015: 4) has created a map of SDGs as a network of targets, where the 16 sectoral SDGs are visually represented as broader circles of different colours, while targets are figured as smaller circles and have the colour of the goal under which they are defined.

Out of the 107 targets, 60 explicitly refer to at least one other goal than the one to which they belong. 19 targets link three goals or more. Such targets create indirect, or ‘third party’ links among goals /.../ The map conveys a sense of an unequally knit network, with some goals being linked to many other goals, while others have fewer links with the rest of the network. (Le Blanc, 2015, p. 3).

Another interesting resource for exploring the connections among the SDGs is the ICSU's analysis of the SDGs interactions (ICSU, 2017). ICSU is the International Council for Science, an umbrella organization whose members are the world's national scientific bodies. In its comprehensive publication *A Guide to SDG Interactions: from Science to Implementation*, they state the following:

/.../ all SDGs interact with one another and (that) by design they are an integrated set of global priorities and objectives that are fundamentally interdependent. Understanding the range of positive and negative interactions among SDGs is key to unlocking their full potential at any scale, as well as to ensuring that progress made in some areas is not made at the expense of progress in others. The nature, strengths and potential impact of these interactions are largely context-specific and depend on the policy options and strategies chosen to pursue them /.../ For many if not all goals, having in place effective governance systems, institutions, partnerships, and intellectual and financial resources is key to an effective, efficient and coherent approach to implementation. (ICSU, 2017, p. 7)

The key ICSU's findings include the fact of SDG7 being one of the most connected goals. According to this study, the other three most synergistic SDGs are SDG2, SDG3 and SDG14. In the ICSU study, using a 7-point scale, a team of scientists evaluated the key target-level interactions between an ‘entry goal’ (e.g., SDG7) and all other goals, and then attributed a score to these interactions based on their expert judgment and as justified through the scientific literature.

The scoring system can be best explained by an example, e.g., the interaction between SDG7 and SDG3, focusing on the effects of clean energy on air quality and health. Namely, sustainable carbon-free energy is largely also pollution-free:

This means that, in most cases, efforts to increase energy access (target 7.1), expand the share of renewables in the energy mix (target 7.2), and promote energy efficiency (target 7.3) will lead to a simultaneous reduction in air pollutant emissions (targeting

the SDG3). As a consequence, interaction between the SDG7 targets and target 3.9 (reducing air pollution) is considered reinforcing and so is allocated a score of +2. Nevertheless, achieving SDG7 may not in itself be enough to meet the air quality targets of SDG3: additional pollution control technologies and measures may be required. (ICSU, 2017, p. 9).

Another interesting example is the interaction between SDG7 and SDG13 on Climate action:

SDG7 has direct interaction with SDG13, since today's fossil-dominated energy system is the main contributor to global GHG emissions. /.../ Renewables (target 7.2) and energy efficiency (target 7.3) are essential elements /.../ Hence, from this standpoint target 13.2 is already on its way to being achieved; and this will help underpin the SDG7 targets. Similarly, targets 13.3 and 13.a are also critical for enabling the successful, rapid deployment of renewable and energy-efficient technologies and consumption patterns /.../ (ICSU, 2017, p. 162)

IDENTIFICATION OF THE SDG-RELATED KNOWLEDGE GAPS

To provide decision-makers and other interested stakeholders with a more holistic view of the complex web of interactions affected by SDG7, the ICSU (2017) identifies key knowledge gaps calling for more analytical attention in the coming years. Filling these gaps will require

/.../ collaborative work between scientists across multiple disciplines, especially in the social sciences (sociology, anthropology, demography, human geography, education, political science, law, communication studies, economics), natural sciences (climate sciences, agricultural sciences, hydrology, atmospheric chemistry, health sciences), engineering, and integrated systems modelling. (ICSU, 2017, p. 167)

Based on our practical experience with the topics, relevant for raising awareness about the energy-related issues, we have identified from the ICSU's (2017) list of the interactions of SDG7 with six other SDGs examples of knowledge gaps in the interaction of SDG7 with the following three SDGs: SDG3 (Good health and well-being), SDG8 (Decent work and economic growth) and SDG13 (Climate action), as presented in Table 1.

SDG7 INTERACTS I. A. WITH THE FOLLOWING SDGS	IDENTIFIED KEY KNOWLEDGE GAPS OF SDG7 WITH THREE OTHER SDGS
SDG3 – Good health and well-being	<ul style="list-style-type: none"> - Distributional impacts of air quality co-benefits of renewables and energy efficiency (for different socio-economic groups in different parts of cities/regions) - Impacts of 'active travel' (walking and cycling) on health and well-being; research focusing on observational/empirical studies
SDG8 – Decent work and economic growth	<ul style="list-style-type: none"> - Net employment and competitiveness impact of the energy system transformation on local, regional and national economies, particularly over near-term - Distributional effects of the energy system transformation, within and across countries (who benefits more vs. less) - Welfare metric that goes beyond the strictly economic formulation of GDP - Energy-related curricula's contribution to science literacy and promotion of better employment and competitiveness - Minimisation of adverse side-effects on those who may lose from the energy system transformation - The role of social innovation in decoupling of energy consumption from economic growth
SDG13 – Climate action	<ul style="list-style-type: none"> - The role of human behaviour in the adoption of energy-efficient, low carbon technologies/consumption patterns - How policies influence consumer preferences toward choices that are beneficial for both individuals and the wider society - How to increase awareness and capacity about solutions to climate change - Potential for the democratisation of the low-carbon energy system (incl. decentralisation, energy cooperatives and other forms of energy initiatives)

Table 1 SDG7 interactions with SDG3, SDG8 and SDG13 and the key knowledge gaps (as identified and adapted from the broader ICSU list of SDG7 interactions, 2017, 167–169).

With so many interactions between the SDG7 and other relevant SDGs, it is clear that integrated, holistic policy frameworks are needed to achieve the network of SDG targets, related to energy and health, well-being, economic, climate and other sustainability issues. ICSU (2017) emphasises that proactive engagement and enhanced coordination /.../ will be required for this to happen effectively. “Otherwise, the ‘silo approach’ /.../ could persist indefinitely. This would not serve the achievement of the SDGs well” (ICSU, 2017, p. 169). Thus, education and awareness-raising of policymakers, researchers, students, and several other stakeholders are important for recognizing the SDGs interactions and the connected knowledge gaps. Finding effective ways to fill these knowledge gaps with appropriate educational resources requires specific competencies which are presented and discussed in the next section.

EDUCATION FOR SUSTAINABILITY AND THE BENEFITS OF OER

KEY COMPETENCIES FOR SUSTAINABILITY

There are specific competencies needed to achieve the SDGs and to consider their interactions (Adomssent & Hoffmann, 2013). LeBlanc (2015, p. 15) suggests that connections between the SDGs could enable easier consideration of synergies and trade-offs across SDG areas which requires a specific set of competencies of key stakeholders, e.g., policymakers, the educational community, the business sector and the citizens, for achieving the SDGs.

In general, competencies describe the specific attributes individuals should have for action and self-organisation in various complex contexts and situations (Adomssent & Hoffmann, 2013; Mulder & Janssen, 2013; Orr et al., 2018; Bregar, et al., 2020; Inamorato dos Santos et al., 2017). They are an interplay of knowledge, capacities, skills, motives and affective dispositions; therefore, they include cognitive, affective, volitional and motivational elements (UNESCO, 2017, p. 10).

Creative and self-organised action is required to deal with the complexities of today’s world. Basic *problem-solving processes* that go strictly according to the plan are not enough anymore. People need to *collaborate, think strategically and critically, and share knowledge*. Wals and Lenglet (2016) call the people equipped with these competencies the »sustainability citizens«, and there is a general agreement (UNESCO, 2017) about the key competencies that allow the sustainability citizens to engage constructively and responsibly with today’s challenges (see Table 2).

A KEY COMPETENCY FOR SUSTAINABILITY	THIS COMPETENCY COMPRISES THE ABILITIES TO:
1. Systems thinking	recognize and understand relationships, analyse complex systems and think of how they are embedded within different domains
2. Anticipatory competency	understand and evaluate multiple futures (possible, probable, and desirable) and create one’s own visions for the future
3. Normative competency	understand and reflect on the norms and values that underlie one’s actions and negotiate sustainability values
4. Strategic competency	collectively develop and implement innovative actions that further sustainability
5. Collaboration	learn from others, understand and respect the needs, perspectives and actions of others (empathy); facilitate collaborative and participatory problem solving
6. Critical thinking	question norms, practices and opinions and reflect on one’s own values, perceptions and actions
7. Self-awareness	reflect on one’s own role in society and continually evaluate and further motivate one’s actions
8. Integrated problem-solving	apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solutions

Table 2 Key competencies for sustainability (UNESCO, 2017, p. 10).

The key competencies for sustainability represent what sustainability citizens particularly need to deal with today's complex challenges: "They are relevant to all SDGs and also enable individuals to relate the different SDGs to each other – to see 'the big picture' of the 2030 Agenda for Sustainable Development" (UNESCO, 2017, p. 11).

THE BENEFITS OF OER FROM THE SUSTAINABILITY COMPETENCIES' PERSPECTIVE

OER and OER-enabled pedagogy with its educational advantages and benefits (Bliss, 2013; Weller, 2014; Wals & Lenglet, 2016; Sulisworo, 2018; Wiley & Hilton, 2018) can significantly contribute towards the strengthening of the key competencies for sustainability education. All benefits of OER should be taken into consideration (Bliss, 2013) but from the sustainability education perspective, the authors suggest a selection of the following key benefits of OER: collaboration and partnerships, knowledge sharing, and communications and community engagement (shown in Figures 1 and 2).

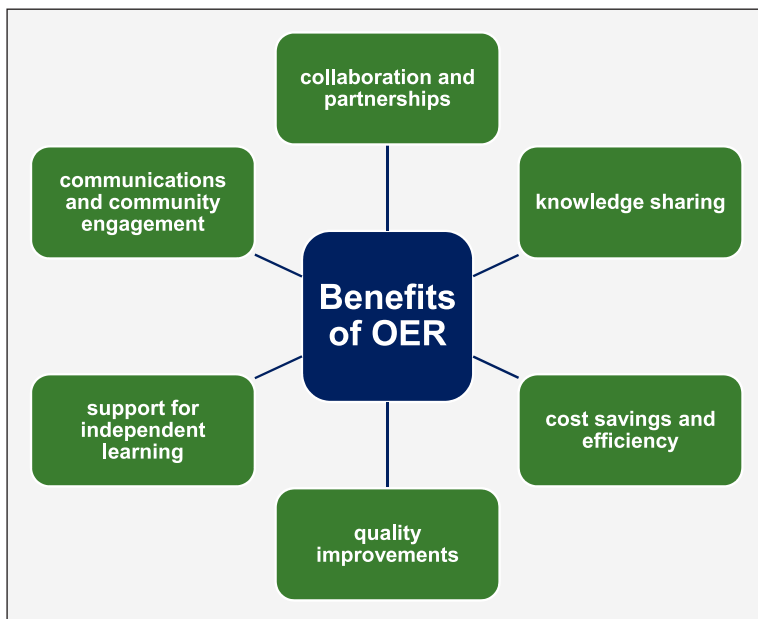


Figure 1 Six general benefits of OER (Bliss, Tonks & Patrick, 2013).

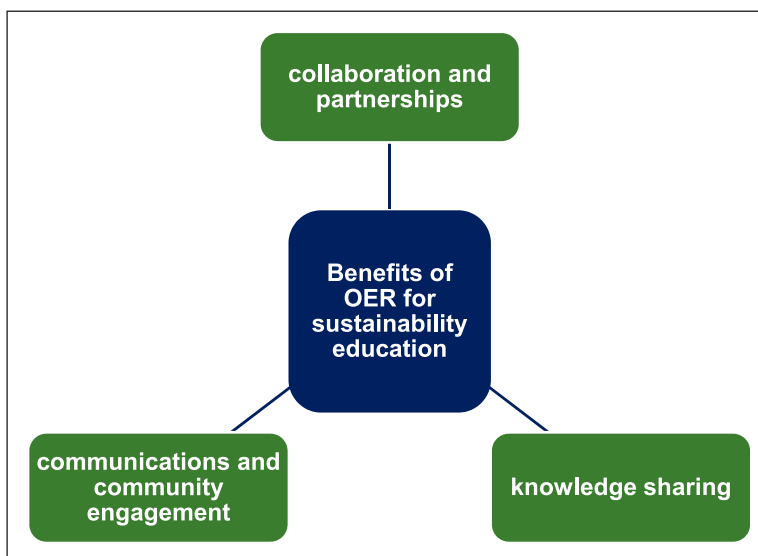


Figure 2 Three key benefits of OER, selected from general benefits of OER (Figure 1), which are of central importance from the perspective of key competencies for education for sustainability.

The following characteristics of each of the key three benefits are important from the perspective of education for sustainability (Table 3).

Based on the defined three key benefits of OER for education for sustainability, we present a case study of teamwork around OER, implemented for the OE4BW and its energy-related topical hub.

BENEFIT OF OER	BRIEF DESCRIPTION
Collaboration and partnerships	OER can create powerful partnering learning opportunities by enabling stakeholders to see, develop, share, and reuse quality OER to meet the learners' unique requirements and needs.
Knowledge sharing	OER enables knowledge sharing for the benefit of all learners and educators by widening access to high-quality resources; they help bridge the gap between formal and informal learning by widening access to quality material outside the classroom and promoting lifelong learning.
Communications and community engagement	OER serve as a model for engaging learners in activities such as development and review and highlight the opportunities through open content.

Table 3 Description of the key benefits of OER, relevant for the education for sustainability competencies and terminologically partly adapted from Bliss, Tonks and Patrick (2013).

CASE STUDY: TEAMWORK FOR EDUCATION FOR SUSTAINABILITY UNDER THE OE4BW INTERNATIONAL ONLINE MENTORING PROGRAMME (THE ENERGY-RELATED HUB)

ABOUT OE4BW PROGRAMME AND ITS HUBS

An international online mentoring programme Open Education for a Better World (OE4BW, 2021) has been created and is managed by the University of Nova Gorica and UNESCO Chair on Open Technologies for Open Educational Resources and Open Learning at the Jožef Stefan Institute. OE4BW supports the development and implementation of OER on topics with social impact according to the SDGs. The program provides an innovative approach to building OER, connecting developers of educational materials with experts volunteering as mentors. The model of the program has been tested in four subsequent implementations in years 2018, 2019, 2020 and 2021. The program is evolving through improvements introduced yearly based on a careful analysis of the process and results (Urbancic et al., 2019; Fabjan, 2021).

OE4BW enrolls mentees from all over the world to support their development of OER based on their project application submitted to the OE4BW call. The process of the project implementation is person-focused, led by the mentee and supported by the mentor through dialogue. The mentee takes the main responsibility for defining his/her needs, and the role of the mentor is to help and support the mentee to find their own solutions. Mentoring relationship is unique, based on the mentee's individual needs and the mentor's knowledge specialisation.

In the 1st year (2018/19), the structure of the OE4BW program was flat. All 14 projects were organized as one group, coordinated by the OE4BW coordinators. In the 2nd year of the program (2019/20), the number of projects increased to 35. This required organisational changes and the OER projects were allocated to three geographical hubs with respect to time zones (North and South America, Europe and Africa, Asia) to make collaboration easier. Hub coordinators were introduced to help the OE4BW coordinators manage the program. In the 3rd year (2019/20), the number of projects raised to 80, leading to five geographical hubs and, importantly, the first topical hub. The decision for adding a topical hub was taken based on several project proposals related to the SDG7 on Affordable and Clean Energy and was called the SDG7 Hub. This novelty was introduced due to organisational reasons, but the potential for improving the performance and opening new perspectives for the development of the program through topical hubs was immediately recognized by OE4BW coordinators and SDG7 Hub coordinators. It was treated as a pilot, and based on positive experience, in the fourth year of OE4BW there were already five topical hubs, one of them being the SDG7 Hub again, but was broadened to include beyond energy related OER, projects related to biodiversity and sustainable living. Nine OER projects have been included in this hub. In parallel, there are still geographical hubs, but topical hubs already prevail this year.

In both program years (2019/20 and 2020/21), the topical hub's co-coordinators implemented a process of hub's teamwork collaboration, knowledge sharing and discussions, oriented towards contextualising individual OER projects as parts of a broader picture of the SDGs network.

Although each of the developers worked on their own individual OER, the hub's teamwork comprised several activities (see Table 4) that strengthened the members' competencies for education for sustainability. Table 4 shows the connection between the a) OE4BW topical hub teamwork activities, b) key competencies for education for sustainability and c) the key benefits of OER, developed in the hub (described in section 3).

OE4BW'S SDG7 HUB & ENERGY, BIODIVERSITY AND SUSTAINABLE LIVING HUB TEAMWORK ACTIVITIES	RELATION TO THE KEY COMPETENCIES FOR EDUCATION FOR SUSTAINABILITY (UNESCO, 2017)	RELATION TO THE OER BENEFITS (BLISS, 2013)
Introductory hub meeting: Joint presentation of the SDG7 and related SDGs, their targets and interactions	Systems thinking competency, strategic competency, integrated problem-solving competency	Knowledge sharing
Regular hub meetings: The motivation of developers to define and present their OER projects from the SDG-interactions perspective, as well as to discuss potential connections to other OER projects in the hub	Strategic competency, critical thinking competency, self-awareness competency	Collaboration and partnerships
Presentation of implemented OER at the OE4BW final event and teamwork promotion: Presentation of OER projects in a topically oriented final event and upload of OER materials into the joint iEnergy Open Library; promotion of the hub's teamwork (events, workshops etc.)	Collaboration competency, self-awareness competency, integrated problem-solving competency	Communications and community engagement

Table 4 OE4BW's hub activities and their connection to the key competencies for education for sustainability and the benefits of OER.

Based on the experience in the SDG7 Hub (the year 2020) and the Energy, Biodiversity and Sustainable Living Hub (the year 2021), especially the discussions among the developers and mentors about the connections of their projects with one or more SDGs, their interconnected targets and the relation of their projects to other OER projects within the hub or the OE4BW program, we suggest a stronger initial focus of the OE4BW call for projects on SDGs, their intersections and related knowledge gaps as it is comprised in the existing OE4BW approach (see Figures 3 and 4). Therefore, a modified approach to OE4BW's call for participation and the subsequent OER development that would better support the closing of the SDG-related knowledge gaps, as presented in sections 1 to 4 of this paper, is offered (see Figures 7 and 8).

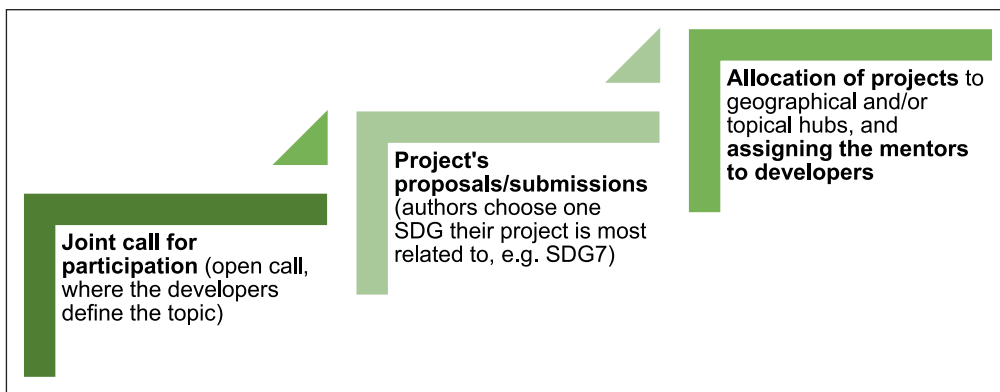


Figure 3 Existing procedure on the general OE4BW level (implemented by the OE4BW organising team).

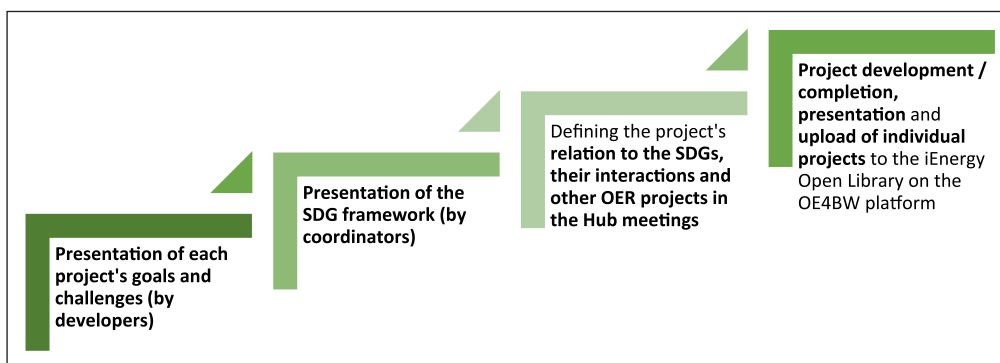


Figure 4 Existing procedure on the topical hub level (implemented by the topical hub coordinators).

Figures 3 and 4 show OE4BW's existing approach to OER development. In line with the joint OE4BW's call for participation, both the SDG7 Hub (in the year 2019/20) and the Energy, Biodiversity and Sustainable Living Hub (in the year 2020/21) followed these steps in the selection, allocation and development of OER projects:

As seen from Table 5, the OE4BW OER projects in both program years were connected to one or more SDGs. Connections were identified based on the presentations of OER developers and the discussions in the hub's meetings.

PROJECT TITLE	DEVELOPER	COUNTRY	CONNECTION(S) TO THE SDG(S)
2020 OE4BW projects (SDG7 Hub)			
History of transport	Satwant Balse	India	SDG7, SDG9, SDG13
Understanding sustainable energy	Basil Dmello	India	SDG7, SDG13
Meet the World of energy	Melita Lenošek Kavcic	Slovenia	SDG7, SDG11, SDG13
Inquiry and concept-based pedagogy in education for sustainable development	Sumit Nair	Sweden	SDG4, , SDG7, SDG13
Climate change education	Pradnya Wakpainjan	India	SDG13, SDG11, SDG7
iEnergy Open Library	Mojca Drevensek	Slovenia	SDG7, SDG4, SDG11, SDG13
2021 OE4BW projects (Energy, Biodiversity and Sustainable Living Hub)			
Towards clean energy	Satwant Balse	India	SDG3, SDG7, SDG8, SDG9, SDG11, SDG12 and SDG14
NEWCOMERS project: OER for new clean energy communities	Mojca Drevensek	Slovenia	SDG7, SDG11, SDG13
Make a dream to stay green	Dibyayoti Bhattacharyja	India	SDG15
URBINAT: Healthy corridors as drivers of social housing neighbourhoods	Saša Dobricic	Slovenia	SDG11
GIS and spatial analysis for biodiversity conservation	Lucy Tallents	UK	SDG15
Plant Tissue Culture	Didwana Vinodkumar	India	SDG8
Basics of Angiosperm Taxonomy	Hensal Rodrigues	India	SDG15
Inclusive Growth & Sustainable Living	Singh Rohit	India	SDG8
Energy @ Wikipedia	Iva Tajnšek	Slovenia	SDG7, SDG4

Table 5 OE4BW program's OER projects, involved in the SDG7 Hub (the year 2019/20) and the Energy, Biodiversity and Sustainable Living Hub (the year 2020/21), and their connections to the SDGs.

Note: Please note that these connections were defined in hub meetings during the development of OER and are subject to change in the project's finalisation phase or its future development.

Identifying the connections to the SDGs enabled a more focused discussion among the OER developers, how their projects relate to other projects and how synergies between their OER could be created, either from the content, tools or dissemination and promotion viewpoint. Visual presentation of connections is seen in Figure 5.

There is one specific SDG7 Hub project that functions as an umbrella OER project for all other existing and future hub projects, namely the iEnergy Open Library (Figure 6). The iEnergy Open Library is an open digital library of OER, related to the SDG7 and connected to several other SDGs. The finished hub's projects are published and promoted in this library. It was developed and launched in 2020 as a result of the teamwork in the SDG7 Hub. It will be further upgraded with the 2021 Energy, Biodiversity and Sustainable Living Hub's new OER.

As seen from Figures 7 and 8 below, presenting a suggested modified approach to OER development in the OE4BW program, the following key changes are suggested for the OE4BW's future modus operandi to increase the OE4BW program's contribution to the effective achievement of the SDGs targets:

- **On the general (OE4BW) level**, the call for participation changes from a call that is open to all OER project topics (as chosen by the developers) to the one that is more narrowly

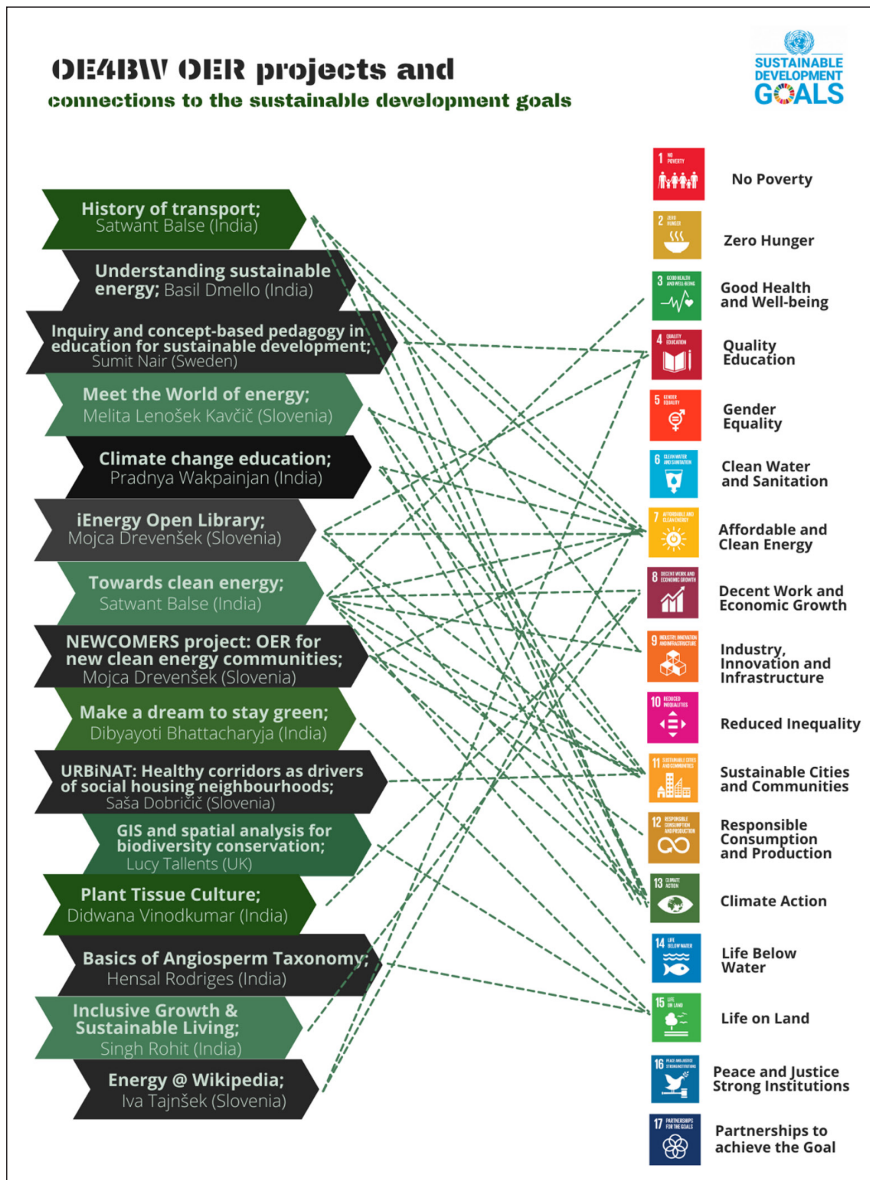


Figure 5 OE4BW projects, developed in the SDG7 Hub (the year 2019/20) and the Energy, Biodiversity and Sustainable Living Hub (the year 2020/21), and their connections to one or more SDGs.



Figure 6 The front page of the iEnergy Open Library.

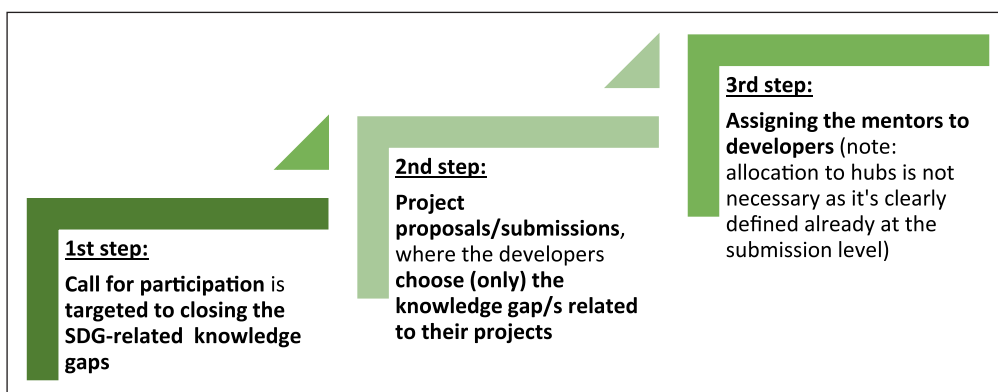


Figure 7 Suggested modified procedure on the general OE4BW level (implemented by the OE4BW organising team).

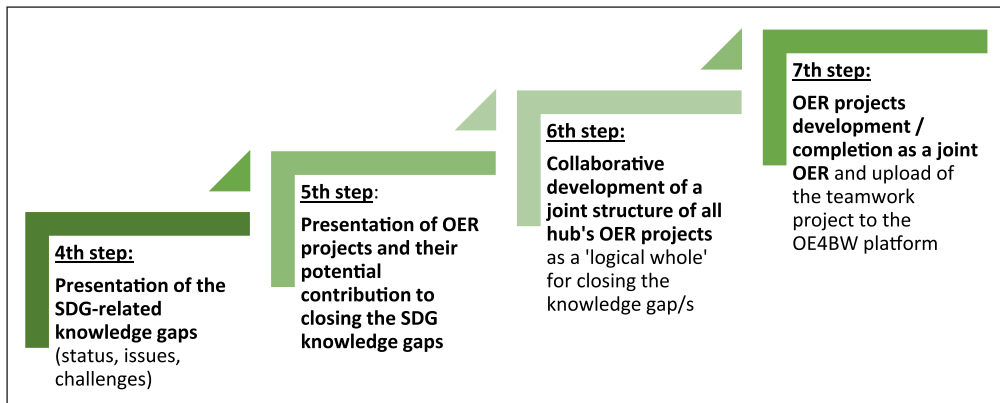


Figure 8 Suggested modified procedure on the topical hub level (implemented by the topical hub coordinators).

targeted at OER projects that can best contribute to closing the clearly defined SDG-related knowledge gaps (see section 2.2 of this paper for examples of knowledge gaps for the SDG7 interactions with three other SDGs). When submitting their proposals, the OER developers select from the list of the pre-defined knowledge gap(s), which of them relate most closely to their projects. This makes it easier for the OE4BW organising team to allocate the submitted project proposals directly to the topical hubs (as the allocation is determined already by the developers during the submission of their proposals). An exemplary list of possible knowledge gaps, related to energy issues (SDG7) can be seen in [Table 6](#).

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- Energy and air quality: the role of low-carbon energy sources and energy efficiency
 - Energy and mobility: the positive impacts of walking and cycling
 - Energy and economy: how does the energy system impact employment and competitiveness (locally, regionally, nationally)?
 - Energy and justice: who benefits (and how) from possible energy transitions?
 - Energy and well-being: How can well-being be measured beyond GDP and what is the role of energy in this?
 - Energy literacy and science literacy: how do they impact better employment and competitiveness?
 - Decoupling energy consumption from economic growth: the role of social innovation
 - Low-carbon technologies for a low-carbon energy future: the role of human behaviour in their adoption
 - Energy and climate change: how to increase awareness and capacity about possible solutions?
 - Democratisation of the low-carbon energy system: what options are out there?
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Table 6 An exemplary list of ten possible topics, derived from the knowledge gaps, as identified in interaction of the SDG7 with three other SDGs.

- **On the topical hub level**, first, the content of the SDG-related knowledge gaps is presented to the group of developers and mentors by the hub coordinators and (in case the hub coordinators are not subject matter experts) by the external partners/experts, who provide further insights into the SDGs, their targets and intersections, and the related knowledge gaps. Then the OER projects are presented by the developers with the focus on their potential contribution to closing the defined knowledge gaps. The key new, value-added aspect of the modified approach to hub coordination is in steps 6 and 7 of the process: the collaborative development of a joint structure (a 'table of content') of the hub's OER projects and their joint contribution to closing the defined knowledge gaps. In this way, all of the hub's projects are structured as a 'logical whole' and at the end, delivered as a joint OER in an open format, pre-chosen either by the OE4BW organising team or selected by the hub members under the guidance of hub coordinators. The joint OER project can be delivered e.g. in the form of an open book, an open course, collaborative content for Wikipedia or published in an open repository etc.

[Figures 7 and 8](#) show a suggested modified approach to OE4BW's OER development, better supporting the closing of the SDG-related knowledge gaps.

The modified approach towards the selection of OER projects, based more closely on their potential to cover the key SDG-related knowledge gaps, would have the benefit of putting together the Open Education and subject matter (e.g., energy, economy, well-being, environment and climate etc.) experts, who as a team could co-create a collaborative, joint OER, consisting of several individual OER, combined into a 'logical whole'. [Table 6](#) offers an exemplary list of ten possible topics, potentially included in a future OE4BW topical call for participation of OER

projects in the SDG7 Hub. The topics are formulated based on the knowledge gaps, identified in interactions of the SDG7 with three other SDGs: SDG3, SDG8 and SDG13, as presented in section 2.2.

CONCLUSIONS AND FUTURE GUIDELINES

A teamwork approach to the collaborative creation of OER can strengthen the understanding of interactions between the Sustainable Development Goals (SDGs) and support the closure of SDG-related knowledge gaps. The experience gained from teamwork activities, implemented in the energy related (SDG7) Hub of the Open Education for a Better World (OE4BW) international online mentoring program emphasize the importance of OER developers' understanding of the SDGs as a *network of targets*. This leads the authors to suggest an improved, modified approach towards the selection and development of OER projects. The suggested model is presented focusing specifically on the SDG7 (energy) Hub but can be easily adapted also to other future topical OE4BW Hubs, covering other SDGs beyond the SDG7. The collaborative aspect of OER creation is crucial. Members of a topical hub should be encouraged to develop their individual OER focusing in advance on specific SDG-related knowledge gaps and to perceive their projects as a *part of a larger whole* or a *part of the broader sustainability-related network of OER*, developed in the hub.

Besides the internal collaboration in the hub and at the OE4BW program level, also the external collaboration with other OER programs, projects and initiatives are important. This can further enhance the reuse, remix and redistribution of OER about the SDGs, regardless of their origin. Examples include the SDG Academy (<https://sdgacademy.org/>) with its topical, SDG-related open online courses, and the educational resources, created as part of the Climate Interactive's En-ROADS simulator (<https://www.climateinteractive.org/tools/en-roads/>). Other potential external resources that could be connected to and promoted by the collaborative topical OER, created under the OE4BW program's topical hubs will be identified and approached in the future. These kinds of external collaborations create synergies and present opportunities for future partnering in sharing and upgrading knowledge in collaborative settings for effective sustainability education. To identify and implement this sharing and upgrading of knowledge efficiently, knowledge technologies like text mining and data mining offer advanced technical promises to tackle the challenges of the fast-growing and dispersed information. In our future work we will apply these technologies for advancement of collaborative building of OER in different ways, from the very identification of knowledge gaps in existing OER to the identification of potential partners, developers as well as mentors with relevant competences needed to fill in these gaps. Further, more focus will be put not only on organizational aspects of the process, but also on the analysis of concrete projects developed in this framework, and on the investigation of added value gained through international mentorship. The suggestions presented in this article will be used and tested in the next launch of the OE4BW program, with the aim of further contributing to the implementation of the SDGs.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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