Education for sustainable development and technology: Why do technological and engineering skills need to be integrated more intensively into learning and teaching?

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Abstract

Education for Sustainable Development (ESD) is fundamentally integrated into the entire education system in Croatia, but also in most other countries around the world. However, the actual implementation of ESD in the school system is associated with numerous challenges and is often reflected in the curricula only declaratively. One of these challenges is that pupils need to acquire holistic (systemic) knowledge so that the problems and challenges of sustainability can be solved in the future. To acquire this knowledge in primary school, students need to be confronted with sustainability challenges and problems that they cannot know, understand or solve without the technological and engineering knowledge behind such problems. Therefore, this paper argues for and proposes a more intensive integration of technical and technological knowledge into the primary school curriculum. The implementation is based on the Concept for Demystifying Technology (CDT), which serves as the main model for the selection and implementation of teaching content and activities in the primary school curriculum. With this model, he proposes a systematic approach to learning and teaching that includes learning about the local community's need for vital resources, a "deep" insight into the technologies that provide them, an insight into the consequences of using technology, and an insight into the methods and technologies that reduce the negative consequences for society and the environment. The students' activities, which would also ensure adequate development of their critical thinking on sustainability issues, should definitely be "anchored" in authentic situations that reflect "real world" situations. Only in this way will today's generations be able to develop knowledge, skills and a way of thinking that will enable them to successfully solve the problems of the future.

Key words:

ESD; critical thinking; primary education; sustainability; technical education

Introduction

Today's world is confronted with numerous challenges that ultimately manifest themselves in serious disruptions to the Earth's natural processes. The most obvious manifestation of this is climate change, which in turn destroys all other resources that sustain life on Earth. These disruptions are largely the result of inappropriate human behaviour and inevitably affect human life and human society. Perhaps the biggest problem is the exploitation, administration and management of key natural resources such as oil, ores, water, agricultural land and forests, seas and oceans. Nevertheless, human society continues to count the consumption of natural capital as income and not as money extraction (Luttenberger, 2019), which speaks in favour of the thesis that the nature of humanity itself requires a change in the consciousness of the moment in which we live. For this reason, sustainability, sustainable development and resilience have become a "mantra" to which there is no alternative if we want to survive on Earth in the long term. In this sense, the social-ecological resilience that we strive for until we achieve sustainability can be seen as the ability to adapt or transform under conditions where we are faced with unexpected changes in social-ecological systems to ensure the continued support of human well-being (Biggs et al. 2015 ; Folke et al., 2016). Therefore, we need to become aware of change and learn how to respond to multiple, long-term and future risks, how to adapt to them and what steps we need to take to change the systems that create risk, vulnerability and/or inequalities (UN-ADB-UNDP, 2018). Awareness is the first, but perhaps the most important step in gradually making human society more resilient and geared towards sustainable, non-devastating development. At the same time, sustainability and sustainable development usually encompass three basic dimensions that people should care about: the environmental, economic and social dimensions (UNESCO, 2015). As these dimensions are often interpreted tendentiously, depending on which interest groups interpret them, institutional (political), cultural and technical dimensions are increasingly being added today (Purvis et al., 2019; Purković, 2024). Sustainable development can therefore be seen as the maintenance of productivity by replacing depleted resources with resources of equal or greater value without degrading or jeopardising natural biotic systems (Kahle and Gurel-Atay, 2014). In other words: We can only take as much "life" from the earth as we are prepared to give back to it. But is this possible under the given circumstances and in the way, we manage resources, produce and run the economy today? Most probably not. In fact, the results of all global action to date show that we have not made significant progress in terms of climate change impacts, biodiversity conservation and the sustainability of the human community (IPCC, 2022). It is therefore already clear today that the problems and challenges of sustainability will have to be solved by future generations, problems that we cannot yet clearly articulate and with technologies that we do not yet know (Purković, 2024). However, the question is whether future generations will have enough awareness, knowledge, wisdom and courage for the necessary changes if we do not sensitise them today and "equip" them with the necessary knowledge and skills, or whether they will continue to repeat the mistakes of their ancestors. For this reason, there is no alternative to education (and upbringing) for sustainable development today, but it should be given significantly more and significantly different attention than we do today. In this sense, technology and the development of technical skills cannot be excluded from this process. After all, technology has caused numerous consequences that have damaged the environment and sustainability, but without technology we will not be able to remedy these consequences or develop further.

The aim of this article is therefore to clarify and argue the importance and role of technology and technical (engineering) skills in education for sustainable development. The problems of implementing ESD in the school system are analysed and guidelines for the integration of ESD in primary education are presented. At the end, a concept for the implementation of ESD is proposed, in which the importance and role of technical-technological knowledge and skills is elaborated, as well as ways of implementation that would reduce the observed problems.

Starting points and implementation of education for sustainable development

Driven by the accelerated destruction of the natural environment, population growth and the associated growing needs, as well as scientific progress, the global community has agreed on 17 Sustainable Development Goals (UN, 2015). This has also led to recommendations to integrate the values of sustainability and sustainable development into all aspects of learning (UNESCO, 2005; UNESCO, 2009; UNESCO, 2012; UNESCO-DESD, 2014). For this reason, in most countries around the world, including Croatia, education for sustainable development (ESD) is in principle integrated into the entire education system (UNESCO-DESD, 2014). This education should be inclusive and interdisciplinary, and the young generation should develop abilities for observation, critical thinking, creativity, adaptability and skills for a good life where they live, but also the tools to build healthy and resilient communities (Robertson, 2017). It should therefore be quality education, as one of the seventeen Sustainable Development Goals, which should support all other goals (Laurie et al., 2016; Bell, 2016; Müller et al., 2021). It should aim at solving sustainability problems, which should always be approached critically and systematically so that individuals can see the problem as a whole and understand the meaning and interrelationships of the individual elements of this whole and act accordingly (Purković et al., 2023). This approach requires an understanding of the whole system, but also an understanding of how things are interconnected (Sterling, 2001; Armstrong, 2005; Capra, 2005; Orr, 2014). From these definitions and expectations, it is clear that the integration, organisation and implementation of ESD in the school system can be very complex and full of numerous challenges and issues, some of which are highlighted here.

Problems with the implementation of ESD in the education system

The first problem that emerges from the analysis of the available sources is the problem of the organisation and actual implementation of ESD. For example, ESD is often implemented as a cross-curricular topic without clear instructions (Purković, 2022), as lessons on the initiative of a few dedicated teachers (Müller et al., 2021); as a project or programme initiative without sufficient feedback on performance (Warner and Elser, 2015) or as an experimental school programme (UNESCO HK, 2015) in which not all students are involved. Although many countries have recently created clearer organisational concepts for the integration of ESD into the school system (Müller et al., 2021), it is evident that it is still not entirely clear how ESD is integrated into the school system and that, unless something changes, it will continue to be present only declaratively in the curricula (Purković, 2022).

Another problem is the identification of ecological literacy and education for sustainable development. Indeed, the approach of learning for sustainable development is not only the development of environmental literacy (Orr, 1992), i.e. awareness of environmental protection (Tilbury and Wortman 2008; Aguayo and Eames, 2017). Although ecology is important, ESD should also consider the social, political and technical-technological context of causes and consequences

(Purković et al., 2023). ESD must necessarily include the development of action competences necessary for the implementation of change (Jensen and Schnack 1997; Jensen, 2002), especially in the context of students' lives. This means that much more than just preaching and teaching about sustainable development, i.e. sustainable development should also be practised (Müller et al., 2021). In other words, students need to learn how to investigate problems, critically assess what is good and what is bad, how to solve problems, how and towards whom to behave socially, but they also need to learn how to create/produce something, how to reuse or recycle something, how to repair something, how to grow something and how to responsibly manage the resources they use on a daily basis (water, food, energy, etc.). This requires their active participation in designing sustainable solutions or solving community problems in order to achieve transformative change towards resilience and sustainability (Sterling, 2001, 2010; Uzzell and Räthzel, 2009; Aguayo and Eames, 2017; Purković, 2022, 2024). It is not enough to simply clean up the environment or teach how people and the living world function.

The third problem observed is seemingly trivial and concerns the lack of direct information (and teaching) for students about the Sustainable Development Goals. Although it is important for the general population to know the Sustainable Development Goals (Bain et al., 2019), most research only mentions the inclusion of the Sustainable Development Goals in ESD, and it is not entirely clear whether students are directly introduced to these goals. From the analysis of the Croatian primary school curriculum (Purković, 2022), it can be concluded that there is no such systematic introduction, but only certain goals are included in teaching through cross-curricular topics within the subject curricula. At the same time, there is no clear and systematic integration of these goals into the teaching process. Although this may seem unimportant, I think that the first step in education for sustainable development should be to familiarise students with the most important goals of sustainable development. In this way, students would not only be informed, but they should also have the opportunity to ask for additional explanations as to why certain goals are mentioned, why they are important and what their achievement contributes to.

The fourth problem is the problem of competent teachers. Research often shows that teachers need additional training to implement ESD (Müller et al., 2021), that they are not sufficiently motivated for ESD (Scherak and Rieckmann, 2022), that they do not have sufficient competences (Purković et al., 2023) or that they are not considered capable of implementing ESD (Vukobratović and Rončević, 2020). This is not unexpected considering the complexity of ESD and the problem of integrating it into the education system. Namely, teachers are expected to master competences based on three dimensions of learning: cognitive (knowledge, understanding, critical thinking), socio-emotional (humanity, value and responsibility, empathy, solidarity, respect) and behavioural (skills development) (EC, 2021). Although teachers in formal education often focus on the cognitive level, the socio-emotional and especially the behavioural dimension (transdisciplinarity) prove to be extremely important for the successful implementation of ESD (Corres et al., 2024). This means that teachers should develop strategies that inspire hope and avoid pessimism in students (Corres et al., 2024), but also skills for participation and action in their own environment and in collaboration with teachers and experts from other disciplines. However, despite numerous, more or less successful examples of teacher training for ESD, the lack of systematic training for educators is still conspicuous.

The fifth and perhaps most important point in terms of developing students' critical thinking and holistic knowledge is the interpretation of the dimensions of sustainable development and the framework of competences for sustainable development. As mentioned in the introductory chapter, ESD encompasses three dimensions: Environmental (ecological), Social and Economic. It follows

from this definition that sustainability and sustainable development is also a cultural (cultural), traditional, linguistic, spiritual, political and national phenomenon, but also primarily an energy-ecological, economic and labour-social issue (Purković et al., 2023). In other words, these dimensions are often considered, learnt and taught separately from each other, without the component that is often their "connective tissue", i.e. the basis for understanding and action, namely engineering and technology. On the other hand, competences for sustainability include specific ways of living (behaviour), ways of thinking and acting, as well as integrated competences needed to solve problems (QAA, 2021; Bunyan, 2024). At the same time, the question arises as to whether it is possible to develop these without engineering (technical) and technological knowledge and skills. Of the 17 Sustainable Development Goals (UN, 2015), 14 are directly related to engineering and technology. For the achievement of certain goals, technology is therefore often a cause (reason), for certain goals a consequence and for a large part of them a means to achieve, mitigate or maintain a certain or desired state of the desired goal. Although technology has unfortunately very often caused numerous disruptions that have brought us to our current state, it cannot be responsible or "at fault" for this. The responsibility always lies with people, i.e. their behaviour patterns, strategies, policies and, above all, economic corporate interests. However, technology is still necessary to satisfy needs, to ensure the survival of human society and to overcome the challenges and problems of sustainability. Therefore, technological and engineering knowledge and skills are necessary for a real understanding of the cause-and-effect problems of sustainability, but also for appropriate action to solve the problem, so they should be an indispensable part of ESD. On the contrary, research in Croatia shows that engineering (technical) and technological knowledge and skills are only marginally included in education for sustainable development (Purković, 2022; Purković et al., 2023). The reasons why the importance of this knowledge is also not emphasised in the examples of ESD practises from other, especially European, countries are not known, although ESD should be realised and promoted through technical education (Pavlova, 2013; Aguayo and Eames, 2017).

Based on the problems described in the implementation of ESD in the education of students, it is not possible to expect the development of the expected competences for sustainability at a level that guarantees the actual solution of sustainability problems in the future. This can only result in students lacking holistic and systematic knowledge and awareness of the problems and goals of sustainability and failing to develop students' critical thinking on these issues. At the same time, such tendencies favour the interests of large corporations and rich countries that have the material and human potential for transformation, while small and poor countries can hardly expect any strengthening of sustainability, resilience and sustainable development, which can be detrimental to their social and cultural survival (Purković, 2024).

Guidelines for the implementation of ESD in primary education

From the problems of education for sustainable development described above, it is relatively easy to conclude that integration into the education system should be guided by the following guidelines:

1. ***A clear framework and timeframe for the implementation of ESD -*** while the widespread concept of ESD to date has opened up the possibility for education systems to adapt to their own environment, it is not fully anchored in reality. It is therefore proposed that a separate subject, "Sustainable Development", be created to give this important area the importance it deserves. The curriculum of this subject should definitely be open in order to give

each local community the opportunity to solve sustainability problems that are tangible for students and teachers. As part of such a curriculum, students should definitely be informed about the Sustainable Development Goals and relate them to the context of their own lives, but also to the context of the local community and economy. The competency framework of this curriculum can be modelled on existing solutions (QAA, 2021; Bunyan, 2024), but it can also be adapted to the strategic interests of a particular country or region.

2. ***Multidisciplinary approach to the realization of ESD*** – this education should go beyond the framework of "ecological indoctrination" (Purković et al., 2023) and provide students with different (multiple) interpretations of the goals, challenges, problems and possible solutions of sustainable development. In this sense, it is illusory to expect fully competent teachers in the near future, but all teachers whose specialty is related to the Sustainable Development Goals should participate in the implementation of ESD. In this way, students will have the opportunity to learn about social, ecological and economic aspects, provided they are scientifically sound. At the same time, technical-technological knowledge is an indispensable segment required for a holistic view of sustainability and the development of students' critical thinking, so it should be much more integrated into this education. This approach to implementing ESD would promote mutual co-operation between teachers, which would reduce their mutual misunderstanding (and frequent underestimation) and alleviate the current problem of teachers' insufficient competence. In the context of this way of organizing and implementing ESD, support from the school and especially from the school headmaster (Müller et al., 2021) is an extremely important predictor of success.

3. **"*Transformative*" *activities of students in ESD -*** in the implementation of ESD it is very important to stimulate students to think, but also to provoke their action in solving sustainability issues and problems. In this context, to stimulate students to think and research, it is extremely important to give them an insight into the macro context of the original reality so that they can recognize the importance and significance of sustainability issues and goals. This segment is most often realized through teaching materials that are "anchored" in authentic representations of situations from the "real world", but also through direct insight into this reality. However, this is not enough to develop the expected competences. Therefore, students should work on concrete solutions to problems that contribute to the realization of one of the sustainability goals. Although the social and economic dimension of such activities is important, the success of solutions at these levels is only possible after a "deep" understanding of the needs, processes and consequences that are in the background of achieving the Sustainable Development Goals (Purković, 2022). For most sustainability goals, this knowledge is technical-technological (technological and engineering) and often also economic, strategic or political, so that it is usually a "black box" for students, but also for educators. Since strategic and political knowledge is even more difficult for primary school students to grasp, they should be represented primarily at higher levels of education, while "visible" knowledge should occupy primary school students. For this reason, scientific, economic, but also technical-technological knowledge and engineering skills are extremely important for the realization of concrete solutions to problems, so that there is no alternative to students' technical activities if one wants to provoke transformative behavior and action of pupils. In this context, information and digital technology should be used primarily as a research means, insight into the macro-context or simulation of reality (Green et al., 2022), while the concrete student activities should be based on vital sustainability issues. These are primarily activities aimed at solving problems related to the production and cultivation of food, energy for heating and transport, housing, the production or recovery of necessary products, the management of drinking and industrial water, ensuring clean air and the environment (Purković,

2024), but also the preservation of natural biodiversity and urban habitats.

The guidelines presented are in no way intended to diminish the importance of cultural, linguistic, national, traditional or other socially important sustainability, which is particularly important for small nations and communities, but merely to emphasize the importance and significance of technical-technological knowledge and skills in education for sustainable development. At the same time, it is repeatedly pointed out that the neglect of technical (engineering) and technological knowledge and skills threatens the sustainability and resilience of small countries and peoples in the long term, but directly, and thus their national, linguistic, cultural and any other social sustainability. In other words, neglecting vital needs and sustainability solutions such as energy, production, resources (technical/technological) and over-reliance on corporate interests will certainly reduce the possibilities of achieving the desired social sustainability. Therefore, it is important to realize that solving the problems and issues of sustainability of a particular country cannot be solved now, all at once and forever, but starts with the education and training of the young generation, who must be educated to solve problems and challenges that we do not yet know. Today, the future of every country and nation depends on the quality of such education. So, we should ask ourselves what we are teaching them today and what skills we are "equipping" them with.

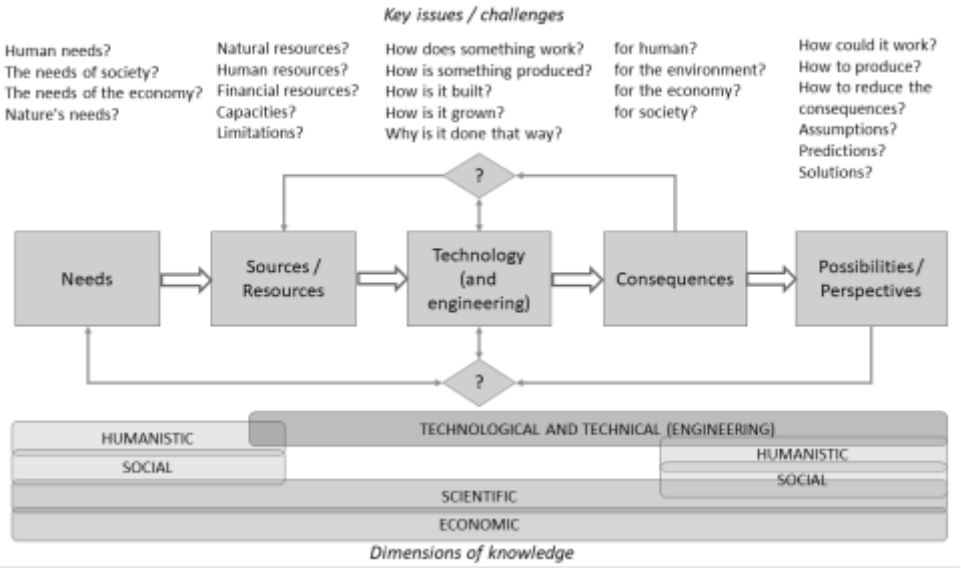
Integration of technology and engineering in ESD

Although the arguments presented in the previous chapters have made it clear why technological knowledge and technical (engineering) skills should be part of ESD, the question arises as to how they can be integrated into such education. To implement such knowledge and skills, the Concept for Demystifying Technology (CDT) (Purković, 2024) was used here, which provides a broad framework for such integration (Figure 1). This is because, unlike the usual concepts related to technical-technological education, whose implementation in teaching practice is often limited to the system of knowledge of a particular discipline, this concept gets out of such frames and limitations. In other words, according to this concept, engineering and technology are "demystified" as needed, i.e. they are activated according to the meaning and importance associated with a "deep" understanding or solution of sustainability problems.

According to this concept, all learning and teaching should begin by familiarizing students with the needs we have as human beings on a daily basis, but also with the needs of society and the economy that ensure the maintenance of a certain standard or range of civilization. At the same time, it is important to sensitize students to the needs of nature, i.e. the conditions that must be met for life on earth to run smoothly. The success of this part of teaching and learning will be measured to some extent by the range and depth of questions students are prepared to ask, as these are often the beginnings of the problems of sustainability and sustainable development from which students' research, thinking and hypothesizing to solve the problem starts. The integration of technical-technological knowledge begins only in the part related to the economy and the material needs of people (water, food, energy, products...), while the needs of nature and other needs of people (spiritual and others) are probably considered within the framework of natural sciences and humanistic knowledge. For this reason, cooperation and a joint approach between teachers from different subjects and/or fields is necessary, because "man does not live by bread and water alone", but is part of nature and must live in harmony with it.

Figure 1

The Concept for Demystifying Technology (CDT) in ESD (Purković, 2024)



The integration of technical-technological knowledge also takes place through a "deep" insight into the resources, capacities and limits within which certain problems can be solved. Only then are they researched, considered and suitable technologies deployed that do justice to the solutions. If the "real" problems are identified and well defined at the beginning of learning and teaching, most of the processes related to sources, resources and the choice and application of technique and technology should be the product of collaborative research, planning and organization by the students and the realization of a project or problem solution. The teacher should primarily play the role of facilitator, using their knowledge and skills to facilitate the students' work and guide them to success. Depending on the problem to be solved or the project carried out, the results of such activities can be various social initiatives, actions or multimedia presentations of solutions to problems, but it is much more useful for the overall development of students if, in addition to everything else, there are also "tangible" solutions, i.e. products created during student activities. In this way, students can already recognize from their own experience some of the consequences of technology and technical activities, some of which are positive and some negative. Since the part relating to sources and resources in the first part (insight), the part relating to technological processes, but also the part relating to the consequences of technology can hardly be learnt entirely through experience, it is important in these segments to carry out the previously described activities "anchored" in authentic situations (anchored learning). Whenever possible, professional field trips and field experiments should be carried out with the students, as a direct insight into the application and consequences of technology can be an excellent stimulus for the students' activities. Only after the learning experiences described above can students explore, consider, propose and present options and solutions that can reduce the negative impacts of technology and ensure sustainability. In this part, the collaboration of teachers from different subjects and their joint participation in these activities should be emphasized once again. Students should research, consider and present sustainable solutions from a social, humanistic, scientific, economic and technological perspective. The teacher's engagement with these "multiple manifestations" of students would also contribute to their cognitive flexibility and professional development.

Despite the fact that the importance of technological and engineering knowledge and skills is emphasized here, the humanistic approach to education for sustainable development should remain at the forefront. For this reason, the ESD curriculum should be free from dictated, pre-defined or politically correct "truths" that are not uncommon in the interpretation of goals and

ways to achieve sustainability. Students should therefore be encouraged to criticize anything they feel should be criticized and the development or change in their thinking, behavior and actions should be based solely on their own experiences and not on the imposition of the "right' way to think or act. Teachers involved in this training should also move away from emphasizing the cognitive approach, where they need to know everything in order to teach it to students, as this is not actually possible and is often detrimental to students' development. Today's knowledge is very fluid and is quickly updated so that the teacher can systematically monitor and adopt it. Although the teacher's knowledge is not unimportant, it is more important to develop students' cognitive mechanisms and critical thinking through their own research, experimentation, argumentation and proof. At the same time, it is more important to develop students' skills in using technical tools and technology, coping skills, co-operation and communication, which will enhance their metacognition, awareness and conscience. For this reason, teachers should invest more effort in researching possible problems and systematizing knowledge and creating materials from which students research and learn information, and less in learning systematic knowledge from a particular discipline on their own. When it comes to the problems of sustainability and sustainable development, and especially the use of technology and its consequences, the teacher should be careful when using IT technology. The information that can be obtained is often of dubious value, sometimes skillfully manipulated to emphasize only what certain interest groups want. In this way, public opinion and desired behavior are influenced and the real truth often remains hidden in the background. For this reason, teachers should focus more on the local environment they know, where they can see the real truth, and work more on empathy and guiding students' concrete and practical multidisciplinary activities. Of course, this requires a radical change in approaches, but also in the planning, preparation, organization and implementation of such teaching, which can only be achieved through long-term practice of such teaching practice and cannot be learned beforehand.

Conclusion

Education for sustainability and sustainable development, i.e. educating young generations to solve sustainability problems, should be one of the priorities of every country today. However, the implementation of ESD in the school system can be an insurmountable organizational and implementation challenge, burdened by existing, very rigid curriculum frameworks, insufficiently clear guidelines, different interpretations of the concept and insufficiently competent teachers.

One possible solution to this problem is to establish ESD as a subject in its own right, based on the concept of demystifying technology, which in many areas determines the problems and challenges of sustainability. This subject should be taught jointly by different teachers who interpret and present sustainability from different perspectives. At the same time, the implementation of problem and project activities in which selected sustainability problems are solved in the community should be a central part of this teaching. At the same time, this requires a more intensive integration of engineering and technological knowledge and skills into such activities, which puts the teachers of this field in the foreground, but also requires a fundamentally different approach to teaching. The knowledge and skills that should emerge from ESD are not only social, economic, environmental, scientific and therefore not only technological (and engineering). They should form a unique whole that makes the student a critical thinker who knows what should be changed and is aware of the ways and paths that can contribute to it. This requires new competences from all teachers involved that go beyond the scope of the disciplines in which they

are "buried" today and that could be developed through mutual collaboration.

Despite all societal efforts and endeavors, it is clear that without a new economic platform that puts today's market competition and economy to the test, and without the development of technologies that enable the gradual realization of sustainability goals, there will be no real progress in their implementation. Partial ecological actions and successes are laudable, but they are only a small step that will not save the world in the long run. That is why we need to raise generations today who think differently, who look at the world critically (and not populistically) in economic and social terms, but who are technologically literate enough to know what is feasible and what is not, and who therefore recognize the most important problems that need to be addressed in the future.

References

Aguayo, C. & Eames, C. (2017). Promoting community socio-ecological sustainability through technology: A case study from Chile. *Int Rev Educ, 63*, 871–895. https://doi.org/10.1007/s11159-017-9685-7

Armstrong, J. (2005). En'owkin: Decision making as if the sustainability mattered. In M. Stone, & Z. Barlow (Eds.), *Ecological literacy: Educating our children for a sustainable world* (pp. 11–17). San Francisco: Sierra Club Books.

Bain, P. G., Kroonenberg, P. M., Johansson, L. O. et al. (2019). Public views of the Sustainable Development Goals across countries. *Nat Sustain, 2*, 819–825. https://doi.org/10.1038/s41893-019-0365-4

Bell, D. (2016). Twenty-first century education: Transformative education for sustainability and responsible citizenship. *J. Teach. Educ. Sustain, 18*, 48–56.

Biggs, R., Schlüter, M. & Schoon, M. L. (eds.) (2015). *Principles for building resilience: sustaining ecosystem services in social-ecological systems.* Cambridge (UK): Cambridge University Press. http://dx.doi.org/10.1017/cbo9781316014240

Bunyan, N. (2024). *Learn More About Education for Sustainable Development (ESD).* Liverpool (UK): University of Liverpool, Centre for Innovation in Education. Retrieved on 25th May 2021, from https://www.imlab.ac.uk/media/livacuk/centre-for-innovation-in-education/diy-guides/learn-more-about-esd/learn-more-about-education-for-sustainable-development.pdf

Capra, F. (2005). Speaking nature's language: Principles for sustainability. In M. Stone, & Z. Barlow (Eds.), *Ecological literacy: Educating our children for a sustainable world* (pp. 18–29). San Francisco: Sierra Club Books.

Corres, A., Ruiz-Mallén, I. & Rieckmann, M. (2024). Educators' competences, motivations and teaching challenges faced in education for sustainable development: what are the interlinkages? *Cogent Education, 11*(1). https://doi.org/10.1080/2331186X.2024.2302408

EC (2021). *Education for environmental sustainability: policies and approaches in European Union Member States: final report.* Luxembourg: Publications Office of the European Union. https://data.europa.eu/doi/10.2766/391

Folke, C., Biggs, R., Norström, A. V., Reyers, B. & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society, 21*(3), 41. http://dx.doi.org/10.5751/ES-08748-210341

Green, C., Molloy, O. & Duggan, J. (2022). An Empirical Study of the Impact of Systems Thinking and Simulation on Sustainability Education. *Sustainability, 14*(1), 394. https://doi.org/10.3390/su14010394

IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. In H. Pörtner, D Roberts, M Tignor, et al. (eds.), *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press. Retrieved on 19th October 2023, from https://www.ipcc.ch/report/ar6/wg2/

Jensen, B. B., Schnack, K. (1997). The action competence approach in environmental education. *Environmental Education Research, 3*(2), 163–178. https://doi.org/10.1080/1350462970030205

Jensen, B. B. (2002). Knowledge, Action and Pro-environmental behaviour. *Environmental Education Research, 8*(3), 325–334. https://doi.org/10.1080/13504620220145474

Kahle, L. R., Gurel-Atay, E. (2014). *Communicating Sustainability for the Green Economy (1st ed.).* Routledge. https://doi.org/10.4324/9781315705491

Laurie, R., Nonoyama-Tarumi, Y., Mckeown, R., Hopkins, C. (2016). Contributions of education for sustainable development (ESD) to quality education: A synthesis of research. *J. Educ. Sustain. Dev., 10*, 226–242.

Müller, U., Dawson, R. Hancock, T. S. & Wang, C. (2021). Implementing ESD in Schools: Perspectives of Principals in Germany, Macau, and the USA. *Sustainability, 13*(17), 9823. https://doi.org/10.3390/su13179823

Orr, D. (1992). *Ecological literacy: Education and the transition to a postmodern world.* New York: State University of New York.

Orr, D. (2014). Systems thinking and the future of cities. *Solutions, 5*(1), 54–61. Retrieved on 17th February 2022, from http://www.resilience.org/stories/2014-05-30/systems-thinking-and-the-future-of-cities

Pavlova, M. (2013). Teaching and learning for sustainable development: ESD research in technology education. *Int J Technol Des Educ, 23*, 733–748. https://doi.org/10.1007/s10798-012-9213-9

Purković, D. (2022). The importance of technical and technological knowledge for the development of students' critical thinking. In Mrnjaus, K. (ed.), *VIII. International European Congress on Social Sciences - Full Text Book* (pp. 326 – 338). Rijeka: IKSAD, 2022.

Purković, D., Kovačević, S. & Runko Luttenberger, L. (2023). Attitudes of Croatian Pupils on the relationship of Environmental Issues and Sustainable Development with Technology and Engineering. *International journal of technology and design education, 33*(4), 1285-1307. https://doi-org/10.1007/s10798-022-09779-6

Purković, D. (2024). *Demystifying Technology as the Basis of Education for Sustainability*. IntechOpen. https://doi.org/10.5772/intechopen.1004517

Purvis, B., Mao, Y. & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability Science, 14*(3), 681–695. https://doi.org/10.1007/s11625-018-0627-5

QAA (2021). *Education for Sustainable Development Guidance.* Gloucester (UK): QAA; York: Advance HE. Retrieved on 12th January 2024, from https://www.qaa.ac.uk/docs/qaa/guidance/education-for-sustainable-development-guidance-executive-summary.pdf?sfvrsn=b121d281_8

Robertson, M. (2017). *Sustainability principles and practice.* New York: Routledge.

Scherak, L. & Rieckmann, M. (2022). Development and Assessment of ESD Competences: Staff Training at the University of Vechta. In P. Vare, Lausselet, N., Rieckmann, M. (Eds.), *Competences in education for sustainable development. Sustainable development goals series* (pp. 121–128). Springer. https://doi.org/10.1007/978-3-030-91055-6_15

Sterling, S. (2001). *Sustainable education: Re-visioning learning and change.* Bristol: Green Books.

Sterling, S. (2010). Learning for resilience, or the resilient learner? Towards a necessary reconciliation in a paradigm of sustainable education. *Environmental Education Research, 16(* 5-6), 511-528. https://doi.org/10.1080/13504622.2010.505427

Tilbury, D. & Wortman, D. (2008). How is community education contributing to sustainability in practice? *Applied Environmental Education and Communication, 7*(3), 83-93. https://doi.org/10.1080/15330150802502171

UN (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. A/RES/70/1. Retrieved on 11th April 2021, from https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981

UN-ADB-UNDP (2018). *Transformation towards sustainable and resilient societies in Asia and the Pacific: Theme report for the Asia-Pacific Forum on Sustainable Development, 2018.* Bangkok, Thailand: United Nations. http://dx.doi.org/10.22617/TCS189274-2

UNESCO (2005). *The DESD at a Glance.* Paris: UNESCO. Retrieved on 21th January 2022, from http://unesdoc.unesco.org/images/0014/001416/141629e.pdf

UNESCO (2009). *Bonn Declaration of the World Conference on Education for Sustainable Development.* Paris: UNESCO. Retrieved on 18th April 2020, from http://www.esd-world-conference-2009.org/fileadmin/download/ESD2009_Bonn Declaration080409.pdf

UNESCO (2012). *Shaping the Education of Tomorrow – Abridged Version.* Paris: UNESCO. Retrieved on 18th February 2021, from http://unesdoc.unesco.org/images/0021/002166/216606e.pdf

UNESCO (2017). *Education for Sustainable Development Goals: learning objectives.* Collectivité auteur: UNESCO. ISBN: 978-92-3-100209-0. Retrieved on 18th February 2021, from https://unesdoc.unesco.org/ark:/48223/pf0000247444

UNESCO (2014). *Roadmap for Implementing the Global Action Programme on Education for Sustainable Development.* Retrieved on 22th February 2021, from https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=1674&menu=35

UNESCO-DESD (2014). *Shaping the Future We Want: UN Decade of Education for Sustainable Development (2005-2014) – FINAL REPORT.* Retrieved on 15th February 2021, from https://unesdoc.unesco.org/ark:/48223/pf0000230171

Uzzell, D. & Räthzel, N. (2009). Transforming environmental psychology. *Journal of Environmental Psychology, 29*(3), 340-350. https://doi.org/10.1016/j.jenvp.2008.11.005

Vukobratović, J. & Rončević, N. (2020). Odgoj i obrazovanje za održivi razvoj kao obrazovni imperativ nastavničke profesije: „Od bilo kakvih materijala važniji je osobni primjer". In: Ćulum Ilić, B. & Buchberger, I. (eds.) *SUVREMENI TRENDOVI I IZAZOVI NASTAVNIČKE PROFESIJE Zbornik Odsjeka za pedagogiju Filozofskog fakulteta Sveučilišta u Rijeci*. Rijeka: University of Rijeka, Faculty of Humanities and Social Sciences, 95-116. Retrieved on 23th February 2021, from http://izdavastvo.ffri.hr/wp-content/uploads/2020/05/Pedagogija_Zbornik_Suvremeni-trendovi-i-izazovi-nastavnicke-profesije_FINAL_Online_izdanje.pdf

Warner, B. & Elser, M. (2015). How do sustainable schools integrate sustainability education? An assessment of certified sustainable K-12 schools in the United States. *The Journal of Environmental Education, 46*, 1–22. https://doi.org/10.1080/00958964.2014.953020

Odgoj danas za sutra:
Premošćivanje jaza između učionice i realnosti
3. međunarodna znanstvena i umjetnička konferencija Učiteljskoga fakulteta Sveučilišta u Zagrebu Suvremene teme u odgoju i obrazovanju – STOO4 u suradnji s Hrvatskom akademijom znanosti i umjetnosti

Obrazovanje za održivi razvoj i tehnologija: Zašto tehnologija i tehničke vještine moraju biti intenzivnije integrirani u učenje i poučavanje?

Sažetak

Obrazovanje za održivi razvoj (OOR) načelno je integrirano u cjeloviti sustav obrazovanja u Hrvatskoj, ali i u većini zemalja u svijetu. Međutim, stvarna implementacija OOR-a u školski sustav obiluje brojnim izazovima te je često samo deklarativno prisutna u kurikulumima. Među tim izazovima su i oni povezani s nužnošću usvajanja holističkih (sustavnih) spoznaja učenika kako bi se problemi i izazovi održivosti u budućnosti mogli rješavati. Usvajanje takvih spoznaja već u osnovnoškolskom obrazovanju zahtijeva suočavanje učenika s izazovima i problemima održivosti, koje nije moguće spoznati, razumjeti, niti rješavati bez tehničko-tehnoloških znanja koja stoje u njihovoj pozadini. Stoga se u ovom radu argumentira i predlaže intenzivnija integracija tehničko-tehnoloških spoznaja u kurikulum osnovnoškolskog obrazovanja. Pritom se implementacija vodi Konceptom za demistifikaciju tehnologije (CDT), kao načelnim modelom za izbor i realizaciju nastavnih sadržaja i aktivnosti u kurikulumu. Ovim modelom predlaže se sustavni pristup učenju i poučavanju koji uključuje upoznavanje potreba lokalne zajednice za ključnim životnim resursima, „duboki“ uvid u tehnologije koje to osiguravaju, uvid u posljedice korištenja tehnologije, te uvid u metode i tehnologije koje umanjuju neželjene posljedice na društvo i okoliš. Aktivnosti učenika, koje bi osigurale i primjereni razvoj kritičkog mišljenja učenika po pitanjima održivosti, zasigurno trebaju biti „usidrene“ u autentičnim situacijama koje odražavaju situacije iz „stvarnog svijeta“. Tek na taj način će se kod današnjih naraštaja moći razvijati znanja, vještine, ali i način razmišljanja kojim će oni moći rješavati probleme budućnosti.

Ključne riječi:

kritičko mišljenje; održivost; OOR; primarno obrazovanje; tehničko obrazovanje

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