ZNAČAJ TEHNIČKO-TEHNOLOŠKH SPOZNAJA ZA RAZVOJ KRITIČKOG RAZMIŠLJANJA UČENIKA

THE IMPORTANCE OF TECHNICAL AND TECHNOLOGICAL KNOWLEDGE FOR THE DEVELOPMENT OF STUDENTS' CRITICAL THINKING

Damir Purković

Sveučilište u Rijeci, Rijeka, Hrvatska

University of Rijeka, Rijeka, Croatia

ORCID ID: 0000-0002-2046-3972

SAŽETAK

Promjene suvremenog svijeta, koje rezultiraju narušavanjem čovjekova prirodnog okoliša te sve većim energetskim, prehrambenim i drugim potrebama, pred mlade naraštaje postavljaju izazove s kojima će se u budućnosti morati suočavati. Pritom male zemlje i gospodarstva pokazuju slabiju otpornost, jer zbog nedovoljno kritičkog odnosa prema takvim problemima i izazovima pribjegavaju gotovim i često neprimjerenim rješenjima. To dugoročno ugrožava njihovu opstojnost, pa treba biti alarm i za obrazovni sustav. U tom se smislu razvoj kritičkog razmišljanja učenika, koje će holistički uključivati i tehničko-tehnološko razumijevanje svijeta, postavlja kao važna karika u ovom procesu.

Ovaj rad donosi istraživanje problema razvoja kritičkog razmišljanja učenika kroz prizmu njihove tehničko-tehnološke osviještenosti u kontekstu hrvatskog osnovnog obrazovanja. Pritom se analiziraju važne tehničko-tehnološke spoznaje bez kojih danas nije moguće razvijati kritičko razmišljanje učenika. To su spoznaje na kojima se zasnivaju prirodni i tehnološki procesi koji osiguravaju opstanak, znanja o tehnologijama koje narušavaju i o onima koje osiguravaju održivost društva, te vještine koje će takva relevantna znanja učenici koristiti za usmjeravanje vlastitog ponašanja. Usporedbom nužnih spoznaja s istraživanjima povezanima s razvojem kritičkog razmišljanja učenika o pitanjima održivosti, ustanovljeno je da učenici nemaju dostatna znanja na temelju kojih bi razvijati kritičko razmišljanje. Daljnjom analizom je ustanovljeno da brojni društveno-ekonomski problemi i izazovi, koji su povezani s tehničko-tehnološkim znanjima bitnima za razvoj kritičkog razmišljanja, u kurikulumu osnovnoškolske nastave nisu zastupljeni ili su zastupljeni samo kao gotova rješenja.

Iz analize se zaključuje da je transformativno tehničko-tehnološko obrazovanje, koje će dati priliku učeniku za djelovanje i donošenje vlastitih odluka, neizostavno za razvoj kritičkog razmišljanja u kontekstu suvremenog društva. Ignoriranje ovog problema može samo produbiti gospodarske probleme zemlje, te uzrokovati daljnju depopulaciju i degradaciju društva.

Ključne riječi: holistički pristup, kritičko razmišljanje, održivost, tehnički odgoj i obrazovanje, tehničko-tehnološka znanja.

ABSTRACT

The changes in the modern world leading to the destruction of man's natural environment and the ever-increasing demand for energy, food and other essentials pose challenges for the younger generation to face in the future. At the same time, small countries and economies show less resilience because they resort to ready-made and often inadequate solutions due to an insufficiently critical attitude towards such problems and challenges. This threatens their survival in the long term, so it should also be an alarm for the education system. In this sense, the development of students' critical thinking, which holistically includes a technical-technological understanding of the world, is an important link in this process.

This paper examines the problem of developing students' critical thinking through the prism of their technical-technological awareness in the context of Croatian primary education. At the same time, important technical-technological knowledge is analysed, without which it is not possible to develop students' critical thinking today. These are the knowledge on which the natural and technological processes that ensure survival are based, the knowledge about technologies that disrupt society and those that ensure the sustainability of society, and the students' abilities to use this relevant knowledge to guide their own behaviour. A comparison of the required knowledge with research on the development of students' critical thinking regarding sustainability issues revealed that students do not have sufficient knowledge to develop critical thinking skills. Further analysis revealed that numerous socioeconomic problems and challenges associated with the technical and technological knowledge required to develop critical thinking are not presented in the primary school curriculum or are presented only as ready-made solutions.

The analysis concludes that transformative technical-technological education that empowers students to act and make their own decisions is essential for the development of critical thinking in the context of modern society. Ignoring this problem can only exacerbate the country's economic problems and lead to further depopulation and degradation of society.

Keywords: critical thinking, holistic approach, sustainability, technical education, technical and technological knowledge.

INTRODUCTION

Inappropriate human actions and the exploitation of natural resources have clearly influenced the global changes facing human society today. In addition to climate change, ecosystem and biodiversity degradation, the integrity of the biosphere has been damaged (Purković et al., 2021), as well as many social communities and their cultural and traditional values that have been sustainable and existed in harmony with nature for thousands of years. In addition, the increasing demand for energy, food, and drinking water as resources whose sustainability is also one of the Sustainable Development Goals (UNESCO, 2015), poses a great challenge for generations to act accordingly in the future. Since it has proven too idealistic to respond to this problem at the level of the global community (Huckle and Wals, 2015), it is clear that action should focus on local communities and states (Purković et al., 2021). In this sense, education for sustainable development should also focus on the problems of the local community and/or state, which is particularly important from the point of view of the resilience and sustainability of small nations and their economies and societies. Although it is often pointed out that sustainable development cannot be achieved only with technological solutions, political regulation or financial instruments, but it is necessary to change the way of thinking and acting (Reditya-Ležaić et al., 2018), it is obvious that such changes will not take place if they are not the students' knowledge about it and activities that will influence their beliefs. Indeed, among the most important learning approaches in education for sustainable development is the development of environmental literacy, critical thinking, and action skills (Huckle and Sterling 1996; Jensen and Schnack, 1997; Orr 2014; Aguayo and Eames, 2017). In this context, action competence, as the ability to act is the component that can lead to real improvement (Aguayo and Eames, 2017), while developed critical thinking is a necessary condition for such appropriate action. Therefore, the question is what the student should know, what activities to perform and in what context to develop critical thinking skills in the context of sustainability and sustainable development.

Critical thinking is understood as an intellectually disciplined process of actively and skilfully conceptualizing, applying, analysing, synthesizing, and/or evaluating information obtained or generated through observation, experience, reflection, deliberation, or communication that serves as a guide to beliefs and actions (Scriven and Paul, 1987). This means that in the process of developing critical thinking, information and facts should be systematically collected and then analysed and evaluated in terms of their clarity, accuracy, relevance, depth, breadth, and logic. Critical thinking, then, involves the subject's ability to process and synthesize information in such a way that he or she can appropriately apply it to tasks for informed decision making and effective problem solving (Heard et al., 2020). This inherently requires the recognition that all reasoning takes place within viewpoints and frames of reference, that it starts from certain goals, that it has an information base, that all data, when used in reasoning, must be interpreted, that interpretation involves concepts, that concepts involve assumptions, and that all basic conclusions in reasoning have implications (Paul et al., 1997). These are also the main reasons why critical thinking cannot be learned and taught as a general or universal skill. While there is an approach whereby critical thinking is taught separately, the requirements presented and the fact that it is almost impossible to transfer what such a program or material teaches to the rest of the curriculum (Lenin, 2019) indicate that this is not an appropriate way. Other approaches call for critical thinking to be taught as an integral part of all subject areas (Wright, 2002) or as a blended model of that teaching. Although it is often said that critical thinking should include the skills of analysis, interpretation, explanation, reasoning, evaluation, and self-regulation (Thomas and Lok, 2015), these and other skills are used in parallel, not discretely or in isolation, and in an authentic context (Heard et al., 2020). Such development is based on questions that focus on the fundamentals of thinking and reasoning, where students should be able to articulate thinking that reflects basic mastery of the intellectual dimensions of reasoning. Since education for sustainable development has an information base that includes many areas, from technological and social to economic and political, neglecting one area will not lead to adequate development of critical thinking. For this reason, education as a whole must become more flexible to accommodate a broader range of student interests and needs and to include the development of skills, knowledge, and dispositions essential for life in the twenty-first century, such as: Collaboration, Critical Thinking, and Problem Solving, while ensuring that knowledge of "curriculum content" is not lost but is available to students as needed (Fox-Turnbull, 2018). In this sense, technology education is often viewed as a discipline that incorporates critical thinking and the application of knowledge and skills because research shows that knowledge is effectively developed through interdisciplinary connections of real-world content or practices (Schwartz et al., 2009). The experience of technology and engineering education cannot occur without integrating other disciplines and using prior knowledge and skills to solve problems (Spicer, 2018), which is a comparative advantage of this education in the context of sustainability and the development of critical thinking. At the same time, research shows that engineering (technical) design activities can help cultivate various forms of so-called "soft" skills such as creativity, critical thinking, collaboration, and communication (Hathcock et al., 2015). Since developing students' ability to deal with problems of sustainability in the future is now considered an important goal of any education and at any level, it is reasonable to expect that this development will holistically include an engineering and technological understanding of the world. Thus, the earlier mastery of basic skills is no longer sufficient, because work, study, and citizenship in the 21st century require that we all know how to think-argue, analyse, weigh evidence, and solve problems. (Wagner, 2008), for which students should be trained from the beginning of their schooling.

With the aim of arguing the importance and significance of engineering (technical) and technological education for the development of students' critical thinking, this paper analyses engineering and technological knowledge and activities from the perspective of growing sustainability problems. At the same time, an analysis of current research on students' awareness of engineering and technology and sustainable development issues in Croatian primary school was conducted. In order to gain insight into the intended ways of developing students' critical thinking, an analysis of the elementary school curriculum was also conducted. With such an insight into the reality of primary education in Croatia, we aim to show the shortcomings, but also the possible directions of development that would promote the development of students' critical thinking.

METHODS AND MATERIALS

The research was conducted as an analysis of relevant literature, curriculum, research findings, and previous research by the author and his colleagues. In order to argue the importance of technology and engineering education for the development of critical thinking in the context of sustainability, an analysis of selected problems and goals of sustainable development, as well as the main features and activities of technology and engineering education, was conducted. By linking the aforementioned goals and characteristics, the operationalization of the development of students' critical thinking in technology and engineering education was elaborated in the context of each of the goals and problems of sustainability and sustainable development. The second part of the analysis focused on studying the awareness of primary school students about the main issues and problems of sustainable development in Croatia. In this way, the aim was to gain insight into students' attitudes towards these issues in order to determine whether they are critical enough, but also familiar with these problems and possible solutions. In the third part, subject curricula and cross-curricular topics related to the goals of sustainability and sustainable development and involved in the development of students' critical thinking are analysed. By comparing the studied student awareness with the planned activities, insight was gained into the possible reasons for the current situation, based on which guidelines and procedures for promoting and improving the development of students' critical thinking can be identified.

ANALYSIS AND DISCUSSION

Although each of the 17 Sustainable Development Goals (UN, 2015) is related to technology and also to education in this area, certain goals are more interrelated and to achieve them it is necessary to develop students' awareness and critical thinking skills from primary school. These are goals related to energy, food, water, and waste. Addressing these issues and future challenges is important to ensure the long-term sustainability of the community and to resist influences that could threaten that sustainability. Therefore, it is extremely important to raise awareness of these issues among the younger generation, but also to educate them to become critical thinkers who are able to look at problems systematically and holistically and find appropriate solutions. The goal of sustainable energy development should ensure access to affordable, reliable, sustainable, and modern energy for all, as well as new economic opportunities and jobs; empower women, children, and youth; provide better education and health; create more sustainable, equitable, and inclusive communities; and provide better protection against and resilience to climate change (UN, 2015). The goal related to food includes the eradication of hunger, food security, improved nutrition, but also the promotion of sustainable agriculture (UN, 2015), which is linked to the empowerment of small farmers, rural development, healthy living and the fight against climate change. The goal related to water refers to ensuring that all people have the right to access to drinking water in an amount and quality that meets their basic needs (UN, 2015), but also to the preservation of aquatic life and the environment, ensuring the sustainability of ecosystems and biodiversity. Waste-related objectives include the application of transparent and science-based risk assessment procedures for the use of chemicals, leading to a reduction of harmful effects on human health and the environment, as well as environmentally sound management of hazardous waste (UN, 2015). This goal is closely related to sustainable production and consumption, as well as sustainable tourism. Ultimately, engineering and technology, science, and capacity building are the main pillars of the means to implement these and other sustainable development goals (UN, 2015), recognizing research, development, implementation, and dissemination of environmentally friendly technologies as an important segment of sustainability, including education for sustainable development. Such technologies can only be created by people who can arrive at solutions through critical thinking.

However, the question arises whether this is possible if the causes of the problems, the consequences and the possibilities are not sufficiently known during education or if the skills with which solutions are to be found are not developed? At the same time, the question arises as to what it even means to think critically in the context of these questions, goals, and problems. Critical thinking is certainly a skill of reasoning that belongs to intellectual processes. Intellectual processes, on the other hand, are mental operations that enable the acquisition of new knowledge, the application of that knowledge to familiar and unique situations, and the control of mental processing necessary for the acquisition and use of knowledge (Johnson, 1992). These processes include the formation of concepts, principles, and understanding necessary for the acquisition of new knowledge, as well as the processes of problem solving, decision making, testing, and composing necessary for the application of knowledge, and oral discourse for the acquisition and application of knowledge (Marzano et al., 1988). In the background of these processes, there are always certain groups of basic thinking skills that students need to develop in order to be able to think critically. These are the abilities to focus (on a problem), analyse, gather information, create (solutions), remember, organize, integrate, and evaluate (Marzano et al., 1988; Johnson, 1992). These skills are consistent with the mental processes that occur during student activities in engineering and technology education. Basically, it is a problem-solving process that reflects the "real world" problems that are at the core of contextual learning of engineering and technology (Hutchinson, 2002; Purković and Bezjak, 2015; Purković and Kovačević, 2020). Thus, the major activities specific to teaching engineering and technology are compatible in many segments with the thinking skills necessary to develop critical thinking. Williams (2000) notes that these activities depend on the type of student and the problem being solved. Key activities include evaluation, communication, modelling, generating ideas, research and testing, production, and documentation. Regardless of the teaching strategy or approach, these activities are always present when teaching engineering and technology, with more or less emphasis on certain activities.

When analysing the attitudes of Croatian primary school students towards issues of ecology and sustainable development (Purković and Kovačević, 2020; Purković et al., 2022), it was found that their attitudes towards certain issues are not acceptable. In particular, these studies include attitudes towards engineering and technology in general, the role of engineering and technology in the context of sustainability, waste management, sustainable (traditional) agriculture and construction, sustainable production, water resources and coastal zone management, nature and animals, and waste management. At the same time, students expressed positive views only toward technology in general, sustainable agriculture and construction, and nature. The results of this research indicate that students do not understand the issues of sustainable waste management, sustainable production, water resource management, and the coastal zone, nor the role of engineering and technology in sustainability. The authors conclude that the technologies that are taught and learned should be accompanied by activities aimed at analysing and critically considering the technological-ecological and socioeconomic reality, as well as the active participation of students and schools in interventions that improve their real environment and life in that environment (Purković et al., 2022).

As far as the elementary school curriculum in Croatia is concerned, the analysis includes the subject curricula of six related subjects and the curriculum of the cross-curricular topic Sustainable Development. The curriculum of the cross-curricular topic Sustainable Development" (OG 7/2019) has adequate objectives and area descriptions, but the learning outcomes are elaborated at an unreasonably low level. At the same time, the learning outcomes do not predict that students will gain insight into engineering and technology knowledge and activities needed to develop critical thinking, so "trivial" learning outcomes related to engineering and technology are mentioned only sporadically. It appears from the learning outcomes that the curriculum is primarily focused on social (cultural) sustainability, and it is not even entirely clear how and by what means this will be implemented. The Technical Culture subject curriculum (OG 7/2019) includes elements necessary for developing critical thinking and achieving sustainable development goals, such as energy and production, but there is insufficient time to implement student activities (35 hours/year). At the same time, learning outcomes and content related to specific sustainable development goals in the areas of water, food, and waste are missing here. In the chemistry curriculum (OG 10/2019), certain concepts support sustainable development goals (changes and processes, energy), but learning outcomes are not expected to be linked to the technological knowledge needed to develop critical thinking. At the same time, the outcomes predict impacts on human health and the environment only at a very general level. In the Physics curriculum (OG 10/2019), certain areas have the potential to meet the Sustainable Development Goals (structure of matter, energy), but the learning outcomes are focused on the narrow scope of physics as a scientific discipline. Again, no linkage is provided to the technological knowledge needed to understand the sustainable development problems. The Biology curriculum (OG 7/2019) includes some concepts that are important for understanding the problems of sustainable development (processes and interdependencies in the living world), but the learning outcomes (needs, consequences) are mainly related to humans. Again, there is no linkage with the technological knowledge necessary for understanding the problems of sustainable development. The curriculum for the subject Nature (OG 7/2019) contains in the macro concept "Processes and Interactions" learning outcomes that are important and well thought out from the point of view of sustainable development. However, only a principled connection with technological knowledge is provided, and the outcomes are very ambitious for 6th grade students and therefore mostly unattainable. In the Geography curriculum (OG 7/2019), certain concepts (sustainability) are well thought out and important from a sustainable development perspective, but the learning outcomes do not provide for integration with technological knowledge, and the connection is only in principle. Learning outcomes from this concept are partially achievable, but only from a scientific and social point of view. From the preceding analysis of the primary school curriculum, it can be concluded that there is a lack of content and activities that integrate technological knowledge into the learning and teaching of sustainable development goals and issues. At the same time, it is clear that there is also a lack of student activities such as student research, discussion, or debate that could develop students' critical thinking skills.

The analysis of the Sustainable Development Goals, the role of technology, and the results of research on student attitudes and the elementary school curriculum point to the need to operationalize the development of students' critical thinking in the context of sustainability. For this reason, in Table 1, for each problem related to sustainable development, topics (subjects) specific to engineering and technology education, mental operations necessary for the development of critical thinking, and classroom activities are related. From the analysis and operationalization of critical thinking in Table 1, it appears that the knowledge of students that should be provided through technology education includes familiarity with the needs, resources/sources and their technological characteristics, the development of "deep" knowledge of the technologies of exploitation, production, processing and management, and knowledge of the consequences, possibilities and limitations of the various technological solutions.

Table 1. Operationalization of the development of critical thinking in the context of the sustainability goals

Problem	*Topic of teaching and learning*	*Contribution of technology education*	*Mental operations of developing critical thinking*	*Activities important for the development of critical thinking*
ENERGY	Needs	Insight into consumption with regard to forms	Concept formation, Adoption of principles, Understanding, Evaluation, Verbal discourse.	Consumption investigation, Testing of products and assemblies, Cognitive apprenticeship, Discussion of needs and consumption.
	Production, transmission and distribution	Direct (deep) insight into technology	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Verbal discourse.	Anchored instruction - technology, Investigation of technologies, Field-trip to the plant, Discussion - technologies, Debate - technologies
	Profitability/ implementation	Insight into costs, limitations and solutions	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Verbal discourse.	Anchored instruction - implementation costs, suitability research, Discussion - feasibility, Debate - the suitability.
	Resources/ exploitation	Direct (deep) insight into resources and exploitation	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction - resources/exploitation, Designing a model, Model/assembly production, Exploitation research, Presentation of results, Discussion of rational use.
	Consequences	Insight into benefits and side effects	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Verbal discourse.	Anchored instruction - benefits and unintended consequences, Consequence research - environment, space, community, Debate - welfare vs. consequences
	Opportunities - trends	Direct insight into alternative (new) technologies An insight into sustainable solutions An insight into "intelligent" management technologies	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction "new" and sustainable technologies, Research - technologies, Devices testing, Designing models/solutions, Production of models/solutions, Discussion of solutions, Debate - options/solutions.

FOOD	Needs	Insight into food needs - local community/state Insight into food needs - world	Concept formation, Adoption of principles, Understanding, Verbal discourse.	Anchored instruction - nutritional needs, Cognitive apprenticeship, Research - needs, habits and problems, Discussion - needs, consumption, problems, solutions.
	Food / agricultural resources	Insight into resources and opportunities in the local community Insights into global resources and opportunities	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Verbal discourse.	Anchored instruction - resources and capacities (local and global), Research - local resources, Discussion - local resources and opportunities
	Food production and processing	An insight into mass food production technologies Insight into food processing technologies Direct (deep) insight into sustainable and traditional food production and processing technologies	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction - production and processing technologies, Research - technology, Problem solving – (problem-project), Design and production of solutions, Discussion of solutions, Debate - traditional vs mass food production.
	Consequences	An insight into the benefits of sustainable production An insight into the negative impacts of agricultural production (on land, water and waterways, health)	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction - sustainable food production, Anchored instruction - negative consequences, Research - consequences, Solving problems - sustainable solutions, Discussion of solutions, Debate - benefits/consequences.
WATER	Needs	Insight into local and global drinking water needs An insight into the economic needs for water Insight into the needs of other living world for water resources	Concept formation, Adoption of principles, Understanding, Verbal discourse.	Anchored instruction - the needs of people, the economy, the living world Research - meeting water needs (local) Discussion - needs for water resources.
	Water resources / exploitation	Insight into drinking water resources and exploitation An insight into the exploitation of	Concept formation, Adoption of principles, Understanding, Evaluation, Verbal discourse.	Anchored instruction - resources (global, local) Anchored learning – insight into water resources exploitation technologies, Research - exploitation of springs, seas and oceans

		water in the economy An insight into the exploitation of seas and oceans		Discussion - technologies of exploitation of water resources.
	Water resources management	Direct (deep) insight into drinking water management technologies An insight into water management technologies for the economy and sanitation	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction - drinking water management technologies Cognitive apprenticeship - water for the economy and sanitation Research - water management technologies Solving the problem - optimizing the use of water resources Debate - water management technologies.
	Consequences	Insight into the necessity and benefits of sustainable water management technologies An insight into the negative consequences of managing water resources An insight into the negative consequences of human activity on watercourses, sea and the coastal zone, health and life, living world	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation), Verbal discourse.	Anchored instruction - consequences of exploitation (springs, watercourses, sea, coastal zone) Cognitive apprenticeship – sustainable technologies Field trip - water distribution, Solving problems - sustainability of water and resources, Discussion - sustainability and water management Debate - technology and water protection.
WASTE	Causes	Insight into the causes of pollution - technologies/phenomena/behaviour Insight into socio-economic causes and policies	Concept formation, Adoption of principles, Understanding, Verbal discourse.	Anchored instruction - waste and pollution (local and global), Research - behaviours and technologies as causes, Rules and policies, Discussion - causes, phenomena, rules.
	Waste management	Insight into the structure of waste as a resource An insight into disposal, recovery and recycling technologies	Concept formation, Adoption of principles, Understanding, Evaluation, Verbal discourse.	Anchored instruction - waste as a resource Anchored instruction - waste management technology Professional excursion - sorting and recycling Research - waste management technologies Discussion - waste management.
	Possibilities	An insight into "zero-waste" and "no-footprint" technologies and production	Concept formation, Adoption of principles, Understanding, Problem solving, Decision making, Evaluation, Compilation (creation),	Anchored instruction - technologies and products without a "footprint" Cognitive apprenticeship - technology as a solution, Sustainable production research (local),

		Insight into product technology without a "footprint"	Verbal discourse.	Solving problems - sustainable waste management, Discussion - sustainable technologies and products.
	Consequences	An insight into the consequences of pollution An insight into the consequences of sustainable technology and production	Concept formation, Adoption of principles, Understanding, Decision making, Evaluation, Verbal discourse.	Anchored instruction - consequences of waste and pollution, Cognitive apprenticeship - impacts on people and nature, Consequences research – conventional vs sustainable, Debate - consequences and benefits of technologies and production.

From Table 1, it can be seen that the planned classroom activities that operationalize the development of critical thinking include various approaches and strategies for successful learning of engineering and technology. These are primarily contextual teaching approaches (Johnson, 2002; Purković and Bezjak, 2015) that focus on the changing context of the environment, where students' active participation in designing sustainable solutions or solving community problems makes this education transformative. This implies teaching and learning processes that help students construct and appropriate new and revised meanings of acquired experiences (Pavlova, 2013). Activities, especially at the early levels, include cognitive apprenticeship as an approach in which the teacher mentally and experientially guides the student through the process of observation, interpretation, and contextualization (Black and McClintock, 1995). Anchored instruction is also often envisioned among the activities, as insight into the macro context of a particular process, problem, technology, or consequences through a film representation of the original reality (Purković and Bezjak, 2015). Indeed, films have proven to be a good medium for learning and teaching critical thinking skills (González-González et al., 2014), which is important here from the point of view of students' insight into technology and its consequences. This is because much of the content in this area, and especially the functioning of large systems, cannot be understood by students if they rely on partial, isolated, and abstract teaching tools. For this reason, this method provides students with a complete insight into reality and the interdependence of all factors and elements of this reality, which allows a holistic and systematic approach to the content and problems. Designing and making (producing) specific models or solutions is a specific feature of technology and engineering education and is also one of the student activities. This specific activity, especially as problem and project- based learning, is extremely important from the point of view of developing basic thinking skills and problem-solving abilities (Purković and Prihoda Perišić, 2020). Moreover, dealing with real technical objects in the implementation of solutions challenges students and at the same time makes them aware of how long and difficult the path is from an idea at the level of an imagination, as a mental construct, to a technical solution that works in the real world. In this way, they learn to better appreciate the value of arguments and facts, as well as the scientific and functional verification of solutions, gradually becoming critical thinkers. Discussions and/or debates are also included for each content. Apart from the fact that these activities consolidate the acquired knowledge of the students, they are also very important from the point of view of the development of critical thinking, but only after the students have gained an insight, a "deep" insight or an experience in relation to the reality. Indeed, in the absence of such insight and experience, students can only have their own opinion, which cannot be the basis for arguing positions or for a reasoned "defence" of their own solutions, so such an opinion is certainly not critical. For each intended contribution, content (topic), and activity from Table 1, the mental operations necessary to realize the intended activities are listed. In this sense, it can be stated that the implementation of the intended student activities often requires students to use almost all the mental operations listed by Marzano et al. (1988). Such student engagement, otherwise necessary in the teaching of engineering and technology, is certainly more likely to lead to some degree of student critical thinking development than the path of developing these skills outside the meaningful context of learning and teaching. From the analysis in Table 1, it is clear that certain knowledge is not exclusively technical-technological in nature, but must be integrated with knowledge from other subjects and fields. These are knowledge from the natural sciences, which should give students a "deep" insight into biological and natural systems and their importance; knowledge from physics and chemistry, about processes that enable prosperity but also harm the environment; and knowledge from geography, which relates to local and global features of the land from which we draw our resources. Nevertheless, in addition to their own content, technology teachers often have the most knowledge related to these topics, such as the basics of science and economic, legal, environmental, and often political knowledge, which makes them the most competent educators in this context.

CONCLUSIONS

Today, the development of students' critical thinking has no alternative when it comes to the goals and problems of sustainability and sustainable development because of the success of meeting the challenges of the future. Although the manifestation of sustainable development is mostly social, natural, and humanistic, the problems it faces are mostly technical and technological, and their solution requires developed critical thinking. However, despite numerous definitions, determinations, and frameworks for teaching critical thinking, very few of these considerations offer the possibility of operationalizing critical thinking in the classroom (Heard et al., 2020). In this sense, technology education lends itself very well to operationalizing critical thinking skills, especially in the context of the chosen Sustainable Development Goals.

Based on the analysis, as a result of the research, a framework for operationalizing the development of critical thinking of primary school students through technical-technological education and in the context of the main problems of sustainable development was proposed. The analysis points to the importance of the knowledge on which the natural and technological processes that ensure survival are based, the knowledge of technologies that disrupt and ensure the sustainability of society, and the development of skills for students to use this relevant knowledge to guide their own behaviour, to think critically, and to solve problems. This requires that students engage in activities in which they practice their own mental operations necessary for the development of critical thinking, which transformative technology education enables them to do. Such activities should allow students to think, act, and make their own decisions. At the same time, students have the right to insight into and reasoned critique of reality, but also the opportunity to gain experience and to construct and adopt a new and revised meaning for the experiences they acquire. From the analysis of a part of the curriculum for primary school in Croatia, it is also clear that technical and technological education must have a significant part in the curriculum.

The content of technology and engineering are not the only ones that should be associated with the Sustainable Development Goals, but it is clear that without them it is not possible to develop students' critical thinking on these issues. Although the level of critical thinking development also depends on students' abilities and teachers' quality, the intensity and depth of learning and teaching of technology will certainly influence this development more than the mere "ecological indoctrination" (Purković et al., 2022) that is often carried out in primary schools today. However, despite the well-reasoned indicators, the proposed framework for operationalizing the development of critical thinking will certainly require modifications and refinements that are only possible if such a framework is part of primary education in the future.

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