

# The Contribution of Education and ICT Knowledge in Sustainable Development Perceptions: The Case of Higher Education Students in Greece

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## Abstract

Environmental problems which threaten humanity have led to the need for sustainable development. This need has become even more evident during the last decades. Education is one of the most important tools to achieve sustainable development by educating people to this direction. The use of ICT in the period of the 4th Industrial Revolution supports quality education and sustainable development. The aim of this research is to examine higher education students' perceptions of sustainable development and analyze how these perceptions can be affected by their education. Data from 871 questionnaires responded by higher education students in Greece were analyzed. Data analyses carried out revealed that the level of ICT knowledge can have an impact on the perceptions of sustainable development. Moreover, it is found that these perceptions are affected by education, while just a small percentage of students have been taught courses related to sustainable development. The research results indicate the need for integrating courses and educational programs related to sustainable development in both the universities and the companies.

## Keywords

Sustainable Development, Sustainability, Education, Higher Education, ICT

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## 1. Introduction

Major environmental problems and the level of the planet's sustainability have been realized this has led both modern states and organizations to search for solutions through plans that are implemented to deal with them (Ntanos, Kyriakopoulos, Chalikias, Arabatzis, & Skordoulis, 2018a; Ntanos et al., 2018b; Ntanos et al., 2019; Skordoulis et al., 2022b; Skordoulis, Ntanos, & Arabatzis, 2020a; Skordoulis et al., 2020b). Through a series of actions to address planet's sustainability, states and organizations aim to develop sustainable development in all sectors including environment, society, economy and culture, through legalized policies both at the international and at the European level. Problems such as the greenhouse effect, thinning out of ozone layer, industrial effluents, the enormous destruction of forest lands, the conditions of megacities must be dealt in terms of sustainable development (Mitoula & Papavasileiou, 2023; Sardanou et al., 2016).

Sustainable development is a goal for humanity and the assurance of future generations and has been set in the main priorities for all stakeholders (governments, businesses, citizens) (Papagrigoriou et al., 2021). The natural environment does not have unlimited capacities, and everyone should have access to natural resources (soil, subsoil, water, atmosphere). Due to limited resources and the need for everyone's equal access to them, the rate of renewal of available resources should not be exceeded, as well as the absorption of waste into the environment at levels that can be tolerated. In addition, sustainability includes socio-economic and cultural factors which must form a production model so that there is a harmonious sustainability of societies. In the context of sustainable development, there must be a balance in the production of goods that will satisfy the needs of people and at the same time will satisfy the need for the lowest expenditure of raw materials by connecting the concept of recycling, the general design based on a bioclimatic plan as well as and renewable energy sources (Gudmundsson & Höjer, 1996; Kemp & Martens, 2007; Mhlanga, 2022).

According to the United Nations, quality education is characterized as the basis for improving sustainable development and, by extension, human life. In order for education to contribute to sustainable development, the United Nations has set goals with 2030 being a milestone for their implementation. These goals are related to ensuring free and equal education at primary and secondary level for all students. It is also important to ensure equal access to education in the rest of the educational levels (technical, professional and universities).

In the context of equal education for all, the elimination of possible discrimination arising from people with disabilities, gender and vulnerable social groups is included. According to the United Nations, all those appropriate skills should be developed in order to lead young people to employment and entrepreneurship with successes in literacy and numeracy. By 2030, learners should have acquired all the knowledge needed to promote sustainable development, equality and human rights in the context of the contribution of culture to sustainable de-

velopment. Finally, the training of teaching staff has been targeted in order to make a clear contribution.

Education for sustainable development must be based on environmental education. Literacy for sustainable development must focus on teaching thought processes capable of understanding and developing new responses to dynamically evolving and changing situations. Warburton (Warburton, 2003) argues that to achieve these goals, teachers must provide a wide range of conceptual and material content, illustrate interconnections and interdependence, and emphasize dynamic rather than fixed structures and processes.

Sustainable development education aims to provide students with the ability to apply the knowledge they have received in a variety of different situations, which is a necessity nowadays so that they can benefit from complex issues of sustainable development (Dale & Newman, 2005). But beyond the students it is important that the education is integrated within the workplace by redesigning the learning infrastructures (Steinemann, 2003).

Literacy for sustainable development can be measured in terms of the acquisition of a set of critical skills by providing a sound framework for education (Dale & Newman, 2005). Education for sustainable development encourages students to develop problem definitions from various perspectives, and most crucially, from interdisciplinary and cross-disciplinary critiques and perspectives.

The 4th Industrial Revolution brings changes in the economy, social dynamics as well as the environment (Kalantonis et al., 2019). The world's interest in environmental changes has existed for several decades, specifically since the first United Nations Conference on Sustainable Development in Stockholm (Seyfang, 2003). The result of this interest is important for the 4th Industrial Revolution because there are integrated projects based on the protection of the environment with the result that the effects are reduced.

According to Popović (Popović, 2020) the 4th Industrial Revolution and the trend of new technologies and innovations it has brought, are changing aspects of human existence. These changes brought about by the 4th Industrial Revolution and spreading to human well-being require the formulation of policies so that education contributes to this new technological environment which must be based on plans directed towards sustainable development. Thus, since the 4th Industrial Revolution primarily refers to the introduction of the information and communication technologies (ICT) in industry (Saniuk et al., 2022), ICT offers the opportunity to create a more sustainable future (Mishra & Maheshwari, 2020; Nchofoung & Asongu, 2022; Suryawanshi & Narkhede, 2015).

Until the early 2020s, according to Oke & Fernandez (Oke & Fernandez, 2020), the education sector seems to have been unprepared to enter the 4th Industrial Revolution. Their research showed that the student learning experience and work-based education can be the way to harness the innovations offered by the 4th Industrial Revolution through research and teaching. Since the beginning of 2000 the interest in entrepreneurship education has increased especially

in universities (Karagianni et al., 2017).

Several researchers have dealt with the analysis of students' perceptions on sustainable development. In their research, Aleixo et al. (Aleixo et al., 2021) found that most of higher education students in Portugal are willing to learn more about sustainable development, while, at the same time they are willing to work in companies that support sustainable development. Moreover, they found that women are more sensitive to sustainability issues and participate more in environmental sustainability actions. The same results are reported for the case of accounting and business administration students in Greece (Ntanos et al., 2020). However, in this case it is reported that the students had a limited knowledge of the scope of sustainability in their sciences. In another research carried out in the UK, it is found that students have an eco-centric orientation since in their education about sustainability is mainly focused on its environmental perspective (Zeegers & Francis Clark, 2014). The way of using technological applications is found to be correlated with learning outcomes (Aivazidi & Michalakelis, 2023; Douros et al., 2023). This is confirmed in the case of sustainability education since a relationship is reported between learning activities, ICT usage, sustainability and employability in a research examining hospitality students in UAE, Switzerland and the UK (Ali et al., 2014). Except for technology, active campus sustainability engagement and positive stakeholder relationship with a university can have a positive impact on students' perceptions on sustainability (Wang et al., 2020). Last, it is reported that students' social factors play an important role in the effectiveness of sustainability initiatives in universities (Jones et al., 2013).

The above results indicate the importance of education in the development of sustainability perceptions and point out that higher education must further incorporate sustainability issues in curricula and academic projects. Quality education is the link between sustainable development and the 4th Industrial Revolution (Sinha & Lutchman, 2021). Thus, the aim of the present research is to examine higher education students' perceptions of sustainable development and how they can be affected by their education.

The rest of the paper is organized as follows; the second section includes analysis of the research materials and methods, the third section includes the research results while the fourth section includes the papers discussion, conclusions and implications.

## 2. Materials and Methods

A structured questionnaire was used to collect research data. The questionnaire was developed based on the research aim and all the questions derived from the relevant literature. All the 25 questions of the questionnaire are closed type, while most of them are developed in a 5-point Likert scales. The questionnaire was developed in an electronic form and was sent to the emails of higher education students studying in Greek universities. In the beginning of the question-

naire there was an informed consent statement explaining to the participants the aim of the research, the confidentiality of their data and their potentiality either to not take part in the research or to withdraw from it any time without any consequence. Finally, 871 valid questionnaires were analyzed. Before the final questionnaire was distributed, a pilot study in 50 students was carried out to test the questionnaire's reliability and validity.

The research data was analyzed using both descriptive and inferential statistics. Referring to the descriptive statistics, percentages, central tendency and variance measures were calculated. Moreover, an evaluation index was calculated in descriptive statistics. This evaluation index is used in order to provide a more scientifically proper way of describing the ordinal variables (Aivazidi & Michalakelis, 2023; Maravelakis et al., 2003). This index is calculated as follows (Maravelakis et al., 2003):

$$I = \frac{P_+ + P_n}{P_- + P_n} \quad (1)$$

where  $P_+$  refers to the cumulative relative frequency of positive responses,  $P_-$  refers to the cumulative relative frequency of negative responses and  $P_n$  refers to the cumulative relative frequency of neutral responses. Based on the above formula, it derives that when the evaluation index's value is higher than 1, the positive responses are dominant (Maravelakis et al., 2003).

As far as the inferential statistics are concerned, Pearson's chi-square test of independence, Mann-Whitney U and Kruskal-Wallis tests for the mean values were carried out. The level of significance for all the statistical analyses was set at 5% as reported in most of the relevant cases of literature.

### 3. Results

#### 3.1. Sample Profile

Initially, students' profile was examined. Students' demographics are presented in **Table 1**.

Based on **Table 1**, most of the examined students are between 18 and 24 years old. Referring to their gender, 45.6% are men, 54.1% are women, while 0.3% of them declared another gender. Moreover, referring to the current studies, most of the examined students are studying for their bachelor's degree. Lastly, most of the respondents stay permanently in urban areas despite the place they study.

#### 3.2. Perceptions of ICT

As already mentioned, ICT can play an important role in sustainable development. Thus, students' knowledge and perceptions of ICT are measured. Initially, **Figure 1** shows that 57.3% of the examined students hold a certification for ICT skills.

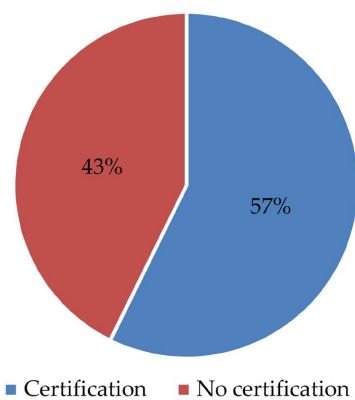
**Table 2** shows participants knowledge on perceptions of ICT. Referring to students' knowledge on the importance of ICT skills as a core characteristic of

**Table 1.** Sample profile.

Variable		% Percent
Age	18 - 24	68.4%
	25 - 35	31.6%
Gender	Male	45.6%
	Female	54.1%
	Other	0.3%
Level of current studies	Bachelor's degree	68.8%
	MSc/PhD	31.2%
Place of permanent residence	Urban area	72.3%
	Semi-urban area	12.3%
	Rural area	10.2%
	Island	5.2%

**Table 2.** Descriptive statistics on ICT knowledge and perceptions.

Variable	% Responses			Mean	Standard deviation	Evaluation index
	Negative	Neutral	Positive			
Do you feel you can use your ICT skills to learn online? (ICT_1)	12.2%	39.8%	46.5%	3.55	0.98	1.65
Do you feel you can apply ICT skills in the context of learning? (ICT_2)	5.0%	27.2%	67.3%	3.93	0.91	2.93
Do you feel you have developed sufficient skills to use ICT effectively? (ICT_3)	9.1%	33.3%	57.1%	3.71	0.95	2.13
Do you feel capable of applying ICT to inform yourself about various concepts? (ICT_4)	3.4%	25.3%	71.1%	3.98	0.84	3.35
Do you find yourself learning through the internet? (ICT_5)	3.9%	22.8%	72.6%	4.06	0.89	3.57
ICT skills can contribute to sustainable development (ICT_6)	6.6%	32.8%	60%	3.77	0.89	2.35
The use of ICT can contribute to sustainable development (ICT_7)	6.8%	37.3%	55.2%	3.69	0.91	2.09

**Figure 1.** ICT skills certification.

the 4th Industrial Revolution, 47.3% of them gave a positive answer. Moreover, the majority of the respondents have positive attitudes concerning ICT usage and applications. However, the highest level of agreement is recorded on learning through internet based on the evaluation index values of the following table. Based on the standard deviations and the mean values it seems that there is a low level of variance between the answers. Last, ICT skills and ICT usage are found to be important enablers of sustainable development based on the responses recorded as well.

### 3.3. Perceptions of Sustainable Development

Referring sustainable development, students seem to have positive attitudes referring to all the questions, based on the data provided in **Table 3**.

Students believe that sustainable development courses should be integrated into both the secondary and the higher education so as the necessary knowledge is disseminated. Moreover, the implementation of sustainable development practices by companies as well as the integration of sustainable development sections in higher education modules are found to be important, however the level of agreement with these perceptions is not as high as with the above-mentioned ones.

Referring to their knowledge, most of the students (77.2%) have never been officially informed about issues relevant to sustainable development, while even more of them (92.3%) have never been taught a relevant course based on the data provided in **Figure 2**. However, 76.2% of the examined students state that they know what sustainable development is.

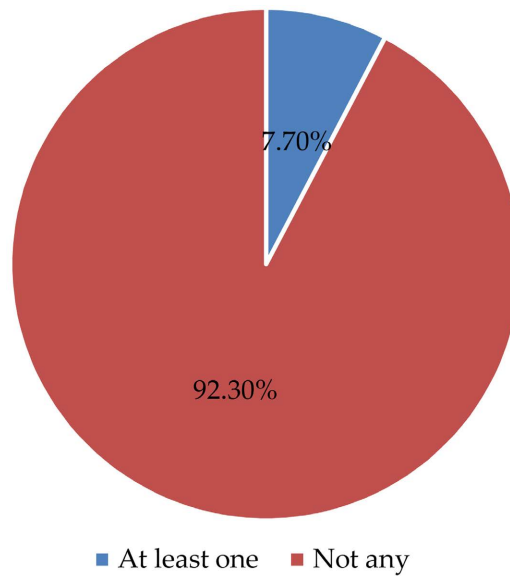
**Table 3.** Descriptive statistics on sustainable development perceptions.

Variable	% Responses			Mean	Standard deviation	Evaluation index
	Negative	Neutral	Positive			
All companies should implement sustainable development practices (SUST_1).	15.1%	38.8%	43.1%	4.55	0.83	1.51
All companies should train their staff with sustainable development practices (SUST_2).	8.8%	38.5%	50.9%	3.61	0.93	1.89
Sustainable development courses should be taught in secondary education so that students receive the knowledge that will make them aware (SUST_3).	5.8%	26.4%	67%	3.42	1.02	2.91
Sustainable development courses should be taught in higher education so that students receive the knowledge that will make them aware (SUST_4).	6.9%	26.1%	65.6%	3.94	0.95	2.78
Professors should integrate into their modules sections that refer to sustainable development (SUST_5).	20.7%	31.5%	47.8%	3.93	0.97	1.51

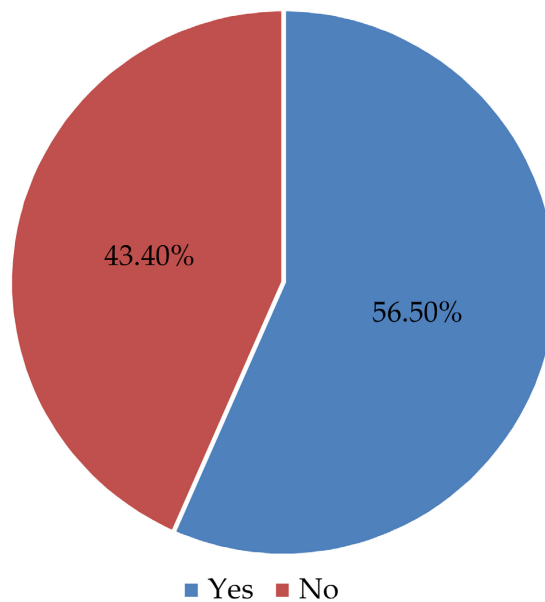
Lastly, the selection of companies stating that they implement practices of sustainable development was examined. Based on **Figure 3**, 56.6% of the students took part in the research state that they prefer to purchase from companies that follow the principles of sustainable development.

### 3.4. Education and Perceptions of Sustainable Development

In this part of the analysis, the relationship between education and perceptions of sustainable development are examined. To do so, a Mann-Whitney U test is initially carried out.



**Figure 2.** Courses taught about sustainable development.



**Figure 3.** Preference for companies that implement sustainable development practices.



Based on the results on **Table 4**, it is obtained that there is a statistically significant difference between the perceptions of the student who have been taught at least one course about sustainable development and these of the students that have never been taught any course. More specifically, the students who have been taught sustainable development courses have more positive perceptions of sustainable development.

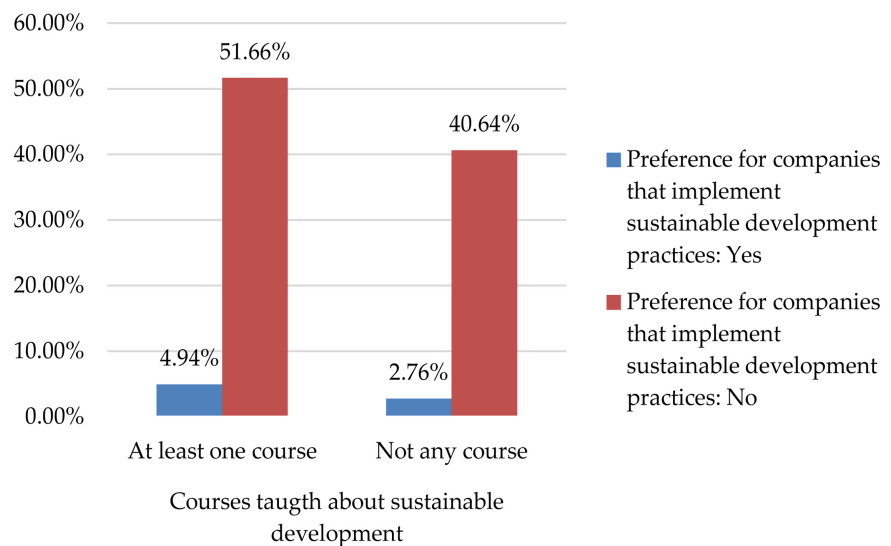
Education on sustainable development is found to be an enabler for various sustainable practices (Al-Naqbi & Alshannag, 2018). Thus, the impact of courses taught about sustainable development on the preference for companies that implement sustainable development practices is examined in **Figure 4**.

To further examine the above relationship, a Pearson's chi-square test of independence is carried out. Based on the test's p-value (p-value = 0.193), the test's null hypotheses of independence cannot be rejected; thus, it is found that the

**Table 4.** Mann-Whitney U test for the examination of sustainable development perceptions based on the relevant courses taught.

Variable <sup>a</sup>	Mean Ranks		p-value
	At least one course about sustainable development	Not any course about sustainable development	
SUST_1	560.87	425.59	0.001
SUST_2	530.27	428.14	0.001
SUST_3	560.87	425.59	0.000
SUST_4	565.93	425.17	0.000
SUST_5	583.86	423.68	0.000

a. Abbreviations provided in **Table 3**.



**Figure 4.** Clustered bar chart for the examination of the preference for companies that implement sustainable development practices based on the relevant courses taught.

preference for companies that implement sustainable development practices is independent of sustainable development courses taught. This can be obtained by the following figure as well.

As reported in the relevant literature, the role of ICT in sustainable development is important (Ali et al., 2014; Nevado-Peña et al., 2019; Suryawanshi & Narkhede, 2015). Thus, the level of ICT knowledge on the perceptions of ICT contribution to sustainable development is examined. To do so, a Mann-Whitney U test is carried out, where ICT skills certification is used as an objective measure of ICT knowledge.

Based on the following **Table 5**, it is obtained that students holding an ICT skills certification have more positive perceptions of ICT's contribution to sustainable development.

### 3.5. Demographics and Perceptions of Sustainable Development

The impact of respondents' demographics on sustainable development perceptions is examined in **Table 6**.

To examine the above-mentioned impact Mann-Whitney U and Kruskal-Wallis tests are carried out. Based on the results of **Table 6**, it is obtained that women have higher perceptions about sustainable development. Moreover, students that permanently reside in urban areas believe at a higher level compared to students who live in other areas that companies must implement sustainable development practices.

## 4. Discussion and Conclusions

The aim of the present research is to examine higher education students' perceptions of sustainable development and how they can be affected by their education. Based on the research results it is obtained that most of the examined students have a certification on ICT while they have positive views on the contribution of ICT usage and ICT skills to sustainable development. Moreover, the certification on ICT has an impact on the above-mentioned perceptions. These results concur with other studies (Al-Naqbi & Alshannag, 2018; Hilty & Hercheui, 2010; Nevado-Peña et al., 2019; Suryawanshi & Narkhede, 2015; Tjoa & Tjoa, 2016). Thus, the use of ICT and the integration of courses that will strengthen ICT skills of students in higher education curricula will further support their views on sustainable development. In this way their actions towards sustainable

**Table 5.** Mann-Whitney U test for the examination of ICT's contribution to sustainable development perceptions based on ICT knowledge.

Variable <sup>a</sup>	Mean Ranks		p-value
	ICT certification	Not ICT certification	
ICT_6	448.22	408.11	0.037
ICT_7	458.23	403.37	0.001

a. Abbreviations provided in **Table 2**.

**Table 6.** Mann-Whitney U and Kruskal-Wallis tests' results for the examination of the impact on demographics on sustainable development perceptions.

Demographics	Perceptions <sup>a</sup>	Test	p-value	Test summary
Gender	SUST_1	Kruskal-Wallis	0.000	Women have higher perceptions
	SUST_2		0.000	Women have higher perceptions
	SUST_3		0.000	Women have higher perceptions
	SUST_4		0.000	Women have higher perceptions
	SUST_5		0.000	Women have higher perceptions
Age	SUST_1	Mann-Whitney U	0.167	No difference between groups
	SUST_2		0.952	No difference between groups
	SUST_3		0.972	No difference between groups
	SUST_4		0.417	No difference between groups
	SUST_5		0.444	No difference between groups
Level of current studies	SUST_1	Mann-Whitney U	0.728	No difference between groups
	SUST_2		0.870	No difference between groups
	SUST_3		0.685	No difference between groups
	SUST_4		0.745	No difference between groups
	SUST_5		0.616	No difference between groups
Place of permanent residence	SUST_1	Kruskal-Wallis	0.003	Higher perceptions in urban areas
	SUST_2		0.429	No difference between groups
	SUST_3		0.500	No difference between groups
	SUST_4		0.736	No difference between groups
	SUST_5		0.638	No difference between groups

a. Abbreviations provided in [Table 3](#).

development could be increased (Agarwal & Alam, 2018; Rivera et al., 2015; Skordoulis et al., 2022a).

Referring to sustainable development perceptions it is found that most of the students have positive views. The perceptions on the need for sustainable development courses integration in the secondary and the higher education curricula have the higher level of agreement. However, only 7.70% of the students have been taught at least any course related to sustainable development. Taking into consideration the above-mentioned results it becomes obvious that it is an immense need to integrate more courses related to sustainable development. In this way students' knowledge on sustainable development will be improved and their actions towards sustainable development could be encouraged (Hellberg & Knutsson, 2018; Kahn, 2008; Nasibulina, 2015; Dannenberg & Grapentin, 2016). However, it should be noted that importance must be given to the whole context of Sustainable Development Goals since in several cases environmental sustainability is exclusively in the spotlight. The integration of sustainable development courses especially in business curricula will support companies' sustainable

way of operation and at same time will enable them to provide higher quality information to their stakeholders; in this way companies performance will be improved as well (Delegkos et al., 2022; Kalantonis et al., 2021a; Kalantonis et al., 2021b; Kalantonis et al., 2014, 2020; van Ravenstein et al., 2013).

Sustainable development is largely connected as a concept to the 4th Industrial Revolution, but this connection comes through a process of training in sustainable development issues. The use of technology appears to be exploited both for educational purposes in a context of autonomous learning and for the development of skills in order to inform about relevant concepts.

The strong belief of the participants is that companies must operate based on the principles of sustainable development and also train their staff in this direction. Markets seem to prefer companies that adopt sustainable development practices. Thus, supporting the triangle economy-society-environment, highlights the degree of competitiveness of these companies against the rest. It seems that most of participants have understood the importance of the use of technology in the digitization of learning but also in the transformation process of businesses in a framework of sustainable development for their operation.

Popović (Popović, 2020), argues that the 4th Industrial Revolution leads to new technologies and innovations that change the way business is done, through smart and sustainable solutions that increase productivity and reduce costs in businesses. This is also the conclusion reached by Roblek et al. (Roblek et al., 2020), who argue that the digitization of businesses following the onset of the COVID-19 pandemic has shown that business operations need to be further digitized. The Internet of Things provides more data that can significantly improve many aspects of a peoples' daily lives, and even help create jobs.

It should be noted that some countries have adopted strategies that make their educational systems more ready to respond to new trends, concluding that the 4th Industrial Revolution will gradually lead to the collapse of traditional education example (Lee et al., 2018; Sahlberg, 2007). Thus, it is proposed that the inclusion of a sustainable development course in secondary and higher education greatly enhances the awareness and information of students and facilitates the educational work of teachers.

A similar conclusion is reached by Ally and Wark (Ally & Wark, 2020) as they believe that it is important to include courses on sustainable development in the curricula of the countries, but they emphasize that the rapid development of technology makes it difficult to a significant extent to accompany it with the curricula and pedagogical approaches that focus on the development of modern digital skills. This is because the rapid changes in technologies require both the education system and the learner to be able to utilize technology effectively and quickly in order to offer educational training services for sustainable development (Ally & Wark, 2020). Thus, as Murenzi et al. (Murenzi et al., 2021) emphasize, it is imperative to invest in the development of ICT infrastructure to educate citizens to foster a culture of sustainable development.

Based on the results of this research, it would be beneficial to carry out further research on the design of the detailed curricula of secondary and higher education so that citizens can be aware of sustainable development from their study years.

Also, it would be beneficial to extend the research to the level of educational programs of companies so that employees can be enabled to follow the technological developments of the 4th Industrial Revolution.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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