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Sustainable Higher Education and Technology-Enhanced Learning (TEL)

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Abstract: The field of education is not immune to advances in sophisticated information and communication technology (ICT). Going beyond the ICT-hype, the objective of this paper is to examine to what extent and how technology-enhanced teaching and learning (TEL) can enhance teaching and learning and, hence, turn them into levers of sustainable socio-economic growth and development. To address these questions, a multidimensional survey was developed and distributed internationally to lecturers/professors active in the field of higher education. The initial point of departure for this study was consistent with the well-referenced in the literature thesis that TEL has profound value added in view of enhancing the teaching and learning process. Yet, as the outcomes of the survey underpinning the discussion in this paper suggest, there is much more is at stake than that. Indeed, it is argued that several conditions need to be fulfilled if technology is to serve as a benefit, and not an obstacle to teaching and learning, and thus boost the delivery of quality education. This paper outlines them.

Keywords: technology-enhanced learning; ICT; higher education; SDGs; sustainable growth and development

1. Introduction

The field of education is not immune to advances in sophisticated information and communication technology (ICT). Indeed, technology-enhanced learning (TEL) has established itself as one of the key topics in the debate on education, ranging from pre-school [1–4] to higher education (HE) [5–7]. Across the field, the thrust of the debate is defined by the question of how the processes of teaching and learning can benefit from the use of technology, and which are the challenges that emerge in this respect.

Technology can serve as a as supportive educational tool. It can be used in the form of digital learning materials. It can accompany the learner in the process of acquiring knowledge in very specific fields [8]. Most importantly, technology may be employed to enhance the skills acquisition process, especially as regards critical thinking, civic engagement, and overall with empowering individuals to seize opportunities and exploit their potential [9]. Still, the use of technology in education requires more thorough reflection. In other words, on the one hand, considerate pressure exists to employ technology in teaching and learning. This is partly driven by the realization that citizens should to be ICT-literate. On the other hand, the field of education is seen as one of the key technology consumers,

which suggests that an intrinsic, albeit contentious, link exists between education and the ICT industry. Considering that the objective of research is to expand our knowledge and understanding of the world around us and to make research findings usable to all stakeholders, the interesting question is whether and how the inroad of technology in the field of education is of value to our societies.

Quality education is one of the Sustainable Development Goals (SDGs) approved at the United Nations (UN) forum in 2015 [10]. In an attempt to go beyond the success of the Millennium Development Goals, the SDGs put forth the imperative to "ensure inclusive and quality education for all and promote lifelong learning" [10]. Quality education may be the key lever of sustainable development [9,11,12] around the world, i.e., including the developing and the developed world. In this view, the access to, the role, and the potential of the use of technology in teaching and learning become more than a slogan. Indeed, the definition of inclusive education [13] points out to the decisive role of technology-enhanced education vis-à-vis boosting technological innovativeness, strengthening the economy, enhancing awareness of environmental sustainability, and ultimately empowering people to secure their wellbeing. Undoubtedly, the inroad of technology in the field of education yields a great promise. As the use of ICT in classroom matures and so the debate on it, it is necessary to get back to basics, and going beyond the ICT-hype, to examine to what extent and how TEL can effectively add to teaching and learning, and, consequently, to the imperative of quality education and sustainable growth and development. To address these questions and concerns, a multidimensional international survey was run. The discussion in this paper draws from insights collected in this way and queries them. The reminder of the paper is structured as follows. Following a brief literature review on TEL, the research methodology and the research model are discussed. In the following section, the results of the survey are presented. Conclusions and recommendations follow.

2. Mapping and Understanding the Debate on Technology Enhanced Learning

Given the fact that technological progress is often more rapid than the logic of longitudinal research, it is necessary to understand how TEL is developing in HE in discourse of sustainable education. To promote sustainable development and to implement the necessary changes in the ongoing transformation process, it is necessary to inquire into the views of stakeholders on the possibilities of using information communication technologies (ICT) and the obstacles and challenges of promoting TEL outcomes that support new innovation. TEL is often assumed to be something that everybody likes and imperceptibly needs, offering new opportunities. This view is also shared by the authors of the article, who believe that technology offers opportunities unused to date. In order to make meaningful use of these possibilities, it is necessary to know the current situation and understand the internal perspective to ascertain how TEL in tertiary education is evaluated by the stakeholders to define further research directions. Looking behind the bubble of fascination with technology to establish how TEL is currently organized in HE will allow an understanding of which emerging aspects should be taken into account, and which directions should be taken, not only to support students in TEL, but also to support professors and adjust educational pathways to ensure sustainable HE for sustainable development.

2.1. Technology-Enhanced Learning in Higher Education

Technology offers immeasurable opportunities to learn, to teach more effectively and to contribute to the process of knowledge construction. At the same time, however, advances in ICT create challenges for the field of education. Literature and field-work suggest that the following three issues constitute the key factors conditioning the possibility of creating value added in education by technology-enhanced approaches to teaching and learning.

(a) Professors' ICT-literacy and competence to use technology to ensure effective TEL.
(b) Students' induction to ICT and development of ICT-competence to interact with technologies to learn and to construct their knowledge in the process of TEL.

(c) Sustainable education and education for sustainability.

Professors' competences in TEL can be examined from several angles. The most important of these is their capacity to support students in the knowledge-building process [14] to assist them in acquiring critical thinking skills. Here, TEL can be used as tool facilitating higher order learners' higher order thinking activities [15,16]. The condition sine qua non for this is that educators are familiar with the development of cognitive processes. They also need to be aware of the factors behind knowledge-building. Finally, they need to be ICT-literate enough to recognize opportunities and possibilities that ICT offers [15–19]. The important point here is that when adopting technology in the teaching and learning process, educators have to be considerate, i.e., they need to develop a predictive analytical competence [15] to be able to gauge the potential outcomes of the use of technology. Literature suggests that often educators either feel unprepared to work with technology [20,21] or they have a negative attitude toward the use of technology all together [22]. Sometimes they feel there is not enough administrative and technical support on the part of the higher education institution at which they work [23]. It is not uncommon that professor feel that the use of technology increases their workload [24–26]. These factors work to the detriment of effective use of technology in teaching and learning process.

From a different angle, some studies reveal that student competence in using technology is inadequate, although they are thought to represent digital natives [27,28] or mobile natives [29,30]. This creates a situation, where educators believe that students are digital natives [31] but, on a daily basis, they see that students' digital competence is not sufficiently developed. Hence, the promise technology offers is not used to its full potential. If digital competence is not purposefully and systematically developed, then technology is used for entertainment purposes in order to access information immediately to avoid cognitive load. However, studies have shown that the instant availability of information online can affect cognitive strategies [32–34]. There are studies that show that students' self-evaluation of their digital competence is higher than their actual digital competence [35–37]. However, this does not change the fact that students want to use technology [35,38]. That is, they are motivated to participate actively in the learning process [39], but they need support in the meaningful use of technology [25,40–42] to support them in the development of ICT-competence [43]. What follows is that it is professors who can serve as those who scaffold the learning if they have the ICT-competence.

2.2. TEL for Sustainable Education

The role of educators, prepared, committed and willing to use different technologies to scaffold learning, is at the heart of the educational process. Countries collaborating in the framework of the Bologna Process have recently agreed that digitalization of education is one of the key objectives of collaborations. By the same token, they pointed to the need of pedagogical innovation to support actions conforming with the imperative of quality education [44]. In this way a direct link between the Bologna Process-TEL and the SDGs was established.

Researchers active in this field long have discussed how various forms of knowledge, academic development and organizational changes are interconnected [45] and how synergies between educators and students can be created [46,47]. In the same context a debate on transformational learning thrives. The latter, it is argued, is the foundation for *sustainable education*, i.e., education where teachers are the drivers of this process—to remain open to change, questioning the epistemological backgrounds upon which they base institutional management and teaching [48]. Some researchers point out that sustainability of higher education is possible if organizational changes are made in the higher education process itself [48] and in curriculum redesign to develop sustainable education [9,49,50].

For the analysis of sustaining education, this article employs the sustainability education academic development (SEAD) framework by Holdsworth and Thomas [48], wherein the main domains are sustainability education, academic development and organizational change. This model is considered most appropriate for analyzing TEL and sustainability interlinkage in order to define the role of

education, where education is the goal to be achieved, but it is, at the same time, a means to achieve other goals [51]. If, in achieving sustainable development goals, education is the driving force behind them, then HE plays an important role in the development of sustainability-related skills and knowledge [48].

3. Research Methodology

3.1. Key Considerations behind This Research and the Research Model

The Research methodology of our study is summarized in Figure 1, below.

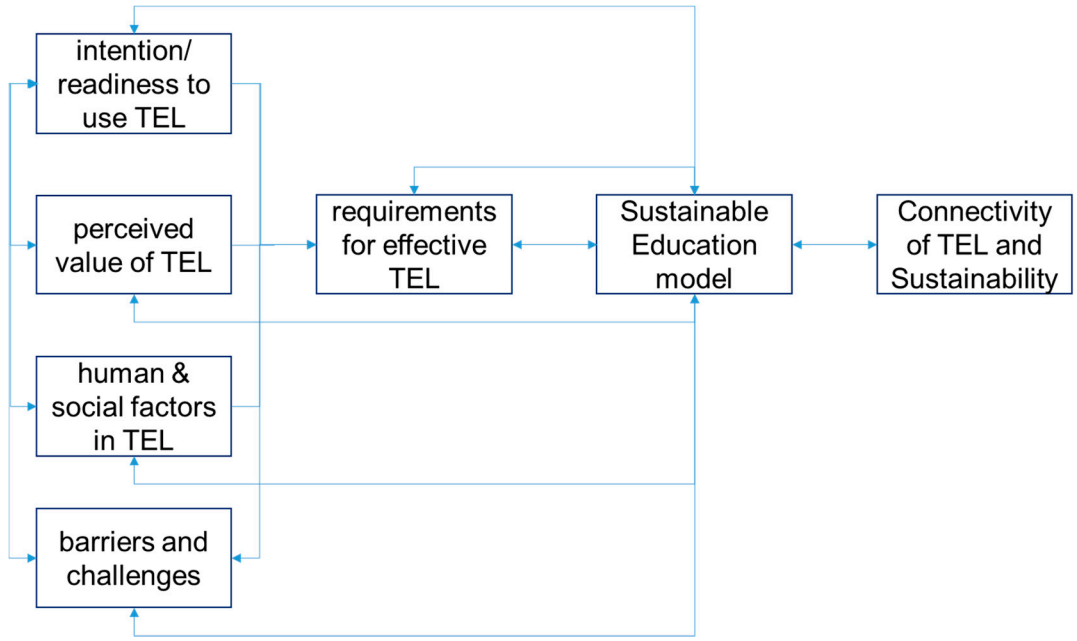

Figure 1. Research Model: Technology Enhanced Learning – Sustainable Education –Sustainability.

The aggregate objectives of the survey underlying the discussion in this paper, can be summarized as follows.

- How faculty perceives the value added of in the education?
- To what extent faculty is ICT-literate and what is the variance across issues and subjects of instruction at Higher Education Institution (HEI)
- What is the readiness of HEI to adopt innovative TEL solutions that challenge the status quo as regards the design, delivery and assessment of teaching and learning?
- In which ways considerate use of TEL, i.e., a use that goes beyond the ICT-hype, can trigger synergies and spillovers consistent with the imperatives ingrained in SDGs?
- What is the impact of education in social inclusive economic growth and how sustainable development goals are related to the exploitation of technology?
- Which are the soft and human factors, related to behavior, motivation and cognitive capacity of faculty and students that promote their intention to use successfully technology in their learning processes?
- How a modern educational institution, deals with the obsolescence of technology and the fast pace of technological evolution in an era where academic institutions have limited resources?
- How the onset of the big data and analytics era impacts education as regards the way of handling sensitive personal data of learners in context of the process geared toward the design of personalized learning solutions?

This list of questions is not exhaustive. A variety of other critical aspects can be integrated in a research model that, as Section 3.3 seeks to demystify the connections between technology, education and sustainability. Prior to elaborating on this, it is necessary to add some definitional rigor to the ensuing debate.

3.2. Definition of Concepts

Several terms have been used in this paper and in the survey underpinning the discussion presented here. The following paragraphs offer a brief explanation of their definitional boundaries.

- ICT is used as a generic term to denote various technologies and technology-enhanced solutions that can be used in the teaching and learning process. Over the past decade, bold developments in this field have taken place, incl. artificial intelligence, advanced learning analytics, cognitive computing and machine learning, Internet of Things, 5G and Sensor networks, together with great development in Data-Warehouses constitute a very promising environment for technology driven learning. Excellent contributions also in computer hardware including 3D printing and haptic interfaces.
- TEL is used as a generic term to denote a teaching and learning process where technologies and technological solutions are used for the provision, enhancement and support of an engaging learning context. It incorporates numerous emerging and streamline technologies including Learning Management Systems, Mobile Learning applications, Virtual and Augmented Reality interventions, cloud learning services, social networking applications for learning, video learning, robotics, etc. It also refers to integrated technology enhanced approaches for the development and codification of open archives of educational resources.
- The term 'professor' and 'educator' is used to denote faculty and researchers who work at various level in HEI. The explicit use of the term 'professor' or 'faculty' serves as a way of crediting their work and commitment. It also serves to express dissatisfaction with the trend discernible across HEI worldwide to refer to professors and faculty by pejorative 'teaching staff'.
- 'Digital (or ICT) competence' refers to the knowledge and skills to use different technologies and technological solutions, both as tools to support the learning process and as learning materials.

3.3. The Research Model

The research design behind this study draws from critical literature review. The latter enabled the authors to identify key variables around which a questionnaire was built. These variables include:

- **Intention/Readiness to use TEL**: The main purpose of this variable is to analyze the capacity of students, faculty and administrators to use, and to exploit TEL in educational context. It incorporates also their basic knowledge to the latest technologies that are integrated in TEL initiatives.
- **Impact of TEL on the perceived value-added of education**: This variable relates to the measurement of educational stakeholders' understanding for the added value of technology enhanced learning initiatives in education. It seeks to understand to what extent stakeholders perceive technology-driven interventions in education as significant and with impact.
- **Human Factors in TEL**: The significance of human and social factors in TEL, and Sustainable Education is integrated in this research variable. The main objective is to understand personality characteristics and psychological factors of students, faculty and administrators that are associated with barriers, fears and hopes of people using technology for educational purposes.
- **Barriers and Challenges**: This variable is directly connected to a variety of factors that hinder or boost people to adopt TEL.
- **Requirements for effective TEL**: One of the key aspects of our research model is also the understanding of prerequisites in a variety of dimensions for the effective design and delivery

of TEL in higher education. With the lenses of Sustainable education this is a critical variable since aggregates.

- **Connectivity of TEL and Sustainability**: This is a bold research variable and relates also with one of the key contributions of our research study. We want to understand how Technology enhanced Learning is related to Sustainability and Sustainable Development Goals. While in the theory several times this connection is promoted, we need to check with empirical data how the responders of our survey understand, interpret and enhance this connection.

The research methodology was developed on the basis of a quantitative field research design [52]. In the first phase of the study, the results of which will be further analyzed in the article, a structured questionnaire was developed using Google Sheets in order to obtaining and summarizing the opinions of respondents from all around the world. Respondents were reached using the personal contacts of the research team, using social media and using universities' web pages. Participation in the survey was voluntary and anonymous. Professors, researchers, students and representatives of HE administration were invited to join the survey. The questionnaire consisted of 24 questions and it was piloted with a small sample of respondents. The first four questions were devoted to obtaining information on the demographic status of HE respondents in terms of gender, country and field of scientific experience. Next, there were 20 questions about different aspects of technology use in the HEI. Some questions offered the option to choose a suggested answer or to give another answer; other questions were formulated as statements which respondents were asked to evaluate on a five-point Likert scale. The questionnaire was validated by two experts in the field of quantitative research methodology. Some of the research results have already been submitted for publication [53]; some are summarized in an article that analyses learning principles using social networks [54]. This article will analyze the findings that describe TEL in HE through the sustainable education prism.

The survey questionnaires were filled out by 140 respondents, of whom 65 were women and 75 were men. These respondents comprised 29 students, 103 professors, six representatives of administration and two respondents who had no formal connection with HE, but who cooperated with HE (IT consultant, business owner, etc.).

In the next stages of the research, the research questions will be specified, specific directions of the research will be defined, and the sample will be expanded to facilitate a comparative analysis of the situation in different countries and differences of opinion between students and professors, as well as between different branches of science.

4. Results

Regarding the areas of scientific expertise indicated by respondents, the breakdown of the data was as follows: Sixty-seven identified as technology/IT/computer science (CS) experts; 40 identified as experts in the social sciences; 36 claimed that their educational studies were different from ICT, but they were currently engaged in TEL aspects of the learning process; 26 indicated that they were experts in learning theories; and 19 other areas were indicated with a small number of experts in these areas. In general, the survey was completed by respondents representing 38 countries, the largest number of respondents coming from Latvia (24), followed by Pakistan with 15 respondents, then Greece and Poland, each with 11 respondents. Seventeen countries are represented by one respondent per country.

The respondents were also asked about their perception of the use of technology in the teaching-learning process and 131 expressed a positive attitude while nine described their attitude as neutral. Respondents also were asked which technologies/tools they thought could be useful in the teaching and learning process. The researchers offered a list of technologies and technological solutions that respondents could use: The most popular responses indicated different online possibilities, including YouTube and videos available online (M = 2.69; SD = 0.814) and personal computers (M = 2.67; SD = 1.042).

In the next step of the survey, respondents were asked to answer seven questions choosing their answer on a scale from 1 to 5, where 1 indicated 'disagree' and 5 'fully agree'. The results are

summarized in Table 1, where means and standard deviations are calculated for groups of respondents. The calculation of means is chosen because the sizes of groups are different; standard deviation is calculated to ascertain the diversity of respondents' views. The results confirm that all the respondents are positive about the role of technologies in the learning process. They are rather more skeptical about the positive outcomes of the learning management system (LMS): The statement "the benefits of the use of LMS are not fully explored by professors" yields a mean of 4.09 and standard deviation of 0.928, which indicates that respondents mostly agree with this statement. These results show that all the stakeholders acknowledge that there are more possibilities in the use of LMS, but the reasons they are not fully used may depend on the fact that LMS is the online space where professors should provide content to support the learning.

The next group of questions for respondents asked what hinders the use of technology-enhanced methods in your teaching or what stops you from enhancing the set of tools you already employ. Respondents were able to choose the most relevant answer from six options provided, as well as use the opportunity to add the answer 'other' to indicate circumstances that hindered the use of technology. The results showed that 47 respondents indicated that there was no infrastructure to use the technology from Wi-Fi or smartphones, or there was no technological support, etc.; 26 respondents indicated that students do not have the skills to use some of the tools/technologies available; 21 respondents stated that they were not quite aware of what they could use to improve their teaching; 19 pointed out that they did not have the time to use it in class; the same number of respondents said that they did not really know how to do this and there was no effective institutional support to help them; 15 respondents thought that students do not really care, while nine stated that they did not really know how to use it and did not have time to deal with it. A comparison of data by respondents' gender did not reveal statistically significant gender differences in the opinions provided [53].

In response to the question of whether, in their teaching, they had ever used technology-enhanced approaches to boost students' awareness of their civic rights and responsibilities, 25 said yes, 53 said no, and 62 said they had not thought of it. This shows that a minority of respondents considered this aspect of sustainable society during the teaching in HE. Respondents who said yes were asked to describe what they did; some examples of responses are that they should be aware of authorship aspects; discussing web science, cyber democracy; women's empowerment; students created multimedia videos that explored social issues, such as the UN SDGs UN; students prepared some infographics about women's and children's rights by searching data from the internet; students explored different ethical factors about migration and their responsibility related to immigrants and their children; and fake news analysis.

To ascertain respondents' opinion on the outcomes of ICT use, they were asked to evaluate different statements about the use of ICT in the teaching and learning process on a five-point scale where 1 = strongly disagree and 5 = fully agree. Results are summarized in Table 2. It can be concluded that respondents evaluate as the most important aspect the statement that use of ICT depends on the availability of infrastructure and devices, where M = 4.08 and total SD = 1.053 (students M = 3.90, professors M = 4.13). This shows the need for structural and organizational support to provide interactive TEL to ensure sustainable education. These results correspond with the previous analysis, where respondents mentioned the factors that hinder their use of technologies in the learning process, the most important factor being the lack of infrastructure.

Table 1. *Case summary*: Outcomes of information and communication technology (ICT) use.

Status		Improves Effectiveness of Teaching and Learning	Promotes Students' Active Engagement in the Process	Fosters Students' Creativity, Independent Thinking and Problem-Solving Skills	Promotes Students' Awareness and Willingness to Look for Additional Information in Other Sources	The Use of LMS Fosters Students' Active Engagement in the Teaching and Learning Process	Might Foster the Development of Students' Liberal Worldview, Open-Mindedness, Respect for Others	The Benefits of the Use of LMS Are Not Fully Explored by Professors
Student	Mean	4.41	4.34	3.93	4.31	3.69	3.83	4.14
	Std. Deviation	0.825	0.897	0.961	0.930	1.105	1.071	1.026
Professor	Mean	4.46	4.36	4.06	4.12	3.79	3.94	4.07
	Std. Deviation	0.697	0.712	0.895	0.832	0.987	0.916	0.932
Administration	Mean	4.67	4.50	4.17	4.00	3.83	4.17	4.17
	Std. Deviation	0.516	0.837	1.329	0.894	0.983	0.983	0.408
Other	Mean	5.00	3.50	3.00	4.00	3.50	3.00	4.50
	Std. Deviation	0.000	0.707	0.000	1.414	0.707	0.000	0.707
Total	Mean	4.46	4.35	4.02	4.15	3.76	3.91	4.09
	Std. Deviation	0.714	0.758	0.925	0.856	1.001	0.948	0.928

1 = disagree; 2 = mostly disagree; 3 = somehow agree; 4 = mostly agree; 5 = fully agree. LMS, learning management system.

Data (see Table 2) show that respondents believe that the use of ICT provides additional opportunities to get access to knowledge for disadvantaged groups ($M = 4.03$). The statement on which respondents agreed less was that use of ICT may contribute to the development of liberal, democratic worldviews and great civic engagement ($M = 3.45$, $SD = 0.955$). These results indicate the need for more attention to be paid to these aspects during the study process to ensure that future generations are not only prepared for the use of technologies, but are also aware about basic principles of sustainable development of society.

Although differences in students' and professors' opinions are not statistically significant, they show an interesting tendency, wherein for all statements which were provided for evaluation, the opinion of professors is more positive ('mostly agree') than that of students. The standard deviations show that students' opinions were more diverse than professors', indicating the need to continue this research to enlarge the sample of students to ascertain their opinion in more detail.

Respondents were further asked to evaluate the challenges/risks related to the use of ICT in the teaching and learning process on a scale from 'strongly disagree' (1) to 'it is the highest risk' (5). Results are summarized in Table 3.

The highest total ($M = 3.60$) is for 'professors are not aware of all the possibilities of ICT' and professors evaluate that risk even higher ($M = 3.7$) than students do ($M = 3.34$). These results again show that support for professors is urgently needed to increase their skills in the use of ICT, not only to improve their technical skills, but also their pedagogical skills in how to use different technologies to increase students' digital competence to support knowledge-building [14] in HE. The system should also look for solutions to balance the workload of professors. These results also indicate the need to establish a new direction in pedagogy to develop the principles of smart pedagogy [15].

In the next part of the survey, respondents were asked to express their opinion about five statements on solutions to ensure meaningful TEL on a scale from 1 to 5, where 1 = it doesn't matter and 5 = it is the highest priority. Results are summarized in Table 4. It can be concluded that all of the proposed solutions have been considered as first priorities by different respondents. The differences in opinion are not statistically significant, however, mean results indicate that the last important assertion is that the ICT used in education should have been previously evaluated in terms of its sustainability ($M = 3.51$, $SD = 1.122$), which indicates that respondents consider sustainability less important than other aspects of ICT use.

As the next step in the data analysis, correlation calculations were made using the Spearman's correlation formula, which is appropriate for data with nonparametric distribution (data distribution was calculated using the Kolmogorov-Smirnov formula). For correlation analysis, the different statements were divided into three groups:

(1) Statements that give information about respondents' opinion on the role of professors together with statements about the infrastructure of HE, as the professors are representatives of a particular HE (Table 5).
(2) Statements that give information about respondents' opinion on students' ability to actively participate in TEL (Table 6).
(3) Statements about education for sustainable society (Table 7).

This division is made by following the logic expressed at the beginning of the paper, where it is stated that there three dimensions of TEL challenges will be analyzed in the discourse on sustainable education.

Table 2. *Case summary*: Opinions on ICT use in the teaching and learning process.

Status		Helps Students to Better Understand the Topic and be Prepared to Use ICT in Knowledge Construction	Helps to Ensure Active Learning Processes for Students	Provides Additional Opportunities to Get Access to Knowledge for Disadvantaged Groups	Boosts the Value of Education	Depends on Teaching Strategies Chosen by Professor	May Contribute to the Development of Liberal, Democratic Worldviews and Great Civic Engagement	Depends on the Age and Ability of Students to Use ICT	Depends on Students' Attitude to ICT	Depends on Professors' Attitude to ICT	Depends on the Availability of Infrastructure and the Devices
Student	Mean	3.59	3.62	3.59	3.69	3.93	3.41	3.31	3.41	3.79	3.90
	Std. Deviation	1.119	1.178	1.296	1.137	1.067	1.150	1.228	1.181	1.207	1.291
Professor	Mean	3.94	3.96	4.17	3.80	4.08	3.45	3.60	3.78	4.14	4.13
	Std. Deviation	1.018	0.928	0.923	0.943	0.967	0.926	1.013	1.019	0.950	0.997
Administration	Mean	3.50	3.67	3.83	3.50	3.33	3.67	3.33	3.17	3.67	3.83
	Std. Deviation	1.225	1.033	0.753	0.837	0.516	0.516	0.816	0.753	0.516	0.753
Other	Mean	3.50	3.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50	5.00
	Std. Deviation	0.707	0.000	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.000
Total	Mean	3.84	3.86	4.03	3.76	4.01	3.45	3.53	3.67	4.04	4.08
	Std. Deviation	1.048	0.991	1.024	0.974	0.978	0.955	1.049	1.049	0.999	1.053

1 = strongly disagree; 2 = mostly disagree; 3 = in some situations it can be so; 4 = mostly agree; 5 = fully agree.

Table 3. *Case summary*: Opinions on challenges/risks related to the use of ICT.

Status		Students Get Bored Very Quickly	Students Lack the Necessary Skills to Use ICT-Enhanced Methods of Teaching	Professors Are Not Aware of All the Possibilities of ICT	There Is Not Enough ICT Available in the Educational Environment	The ICT Used in Education Is Not Interactive Enough to Ensure Active Learning Processes
Student	Mean	2.83	2.41	3.34	2.86	3.38
	Std. Deviation	0.966	1.018	1.173	1.187	1.293
Professor	Mean	2.79	2.56	3.70	3.37	3.15
	Std. Deviation	0.882	0.946	0.979	1.010	1.141
Administration	Mean	2.17	2.67	3.00	2.67	2.83
	Std. Deviation	0.753	1.033	0.894	1.506	1.329
Other	Mean	3.50	3.00	4.00	4.00	4.00
	Std. Deviation	0.707	1.414	0.000	0.000	0.000
Total	Mean	2.78	2.54	3.60	3.24	3.19
	Std. Deviation	0.898	0.962	1.023	1.085	1.175

1 = strongly disagree; 2 = mostly disagree; 3 = in some situations it can be a risk; 4 = in most situations it can be a risk; 5 = it is the highest risk.

Table 4. *Case summary*: Opinions on what should be done.

Status		Professors Should Be Trained to Use ICT in the Teaching Process	There Should Be More Cooperation among Technology Developers and Educational Institutions	There Should Be More ICT Available in the Educational Environment	The ICT Used in Education Should Have Been Previously Evaluated in View of Its Sustainability	The ICT Used in Education Should Have a High Level of Interactivity to Ensure Active Learning Processes
Student	Mean	3.76	3.86	3.69	3.24	3.69
	Std. Deviation	1.091	1.187	1.004	1.154	1.339
Professor	Mean	3.95	3.93	3.84	3.60	3.96
	Std. Deviation	0.954	0.993	1.017	1.106	1.066
Administration	Mean	3.67	3.50	3.33	3.33	4.17
	Std. Deviation	1.366	0.837	0.816	1.366	0.753
Other	Mean	3.50	4.00	4.00	3.50	4.00
	Std. Deviation	0.707	0.000	0.000	0.707	0.000
Total	Mean	3.89	3.90	3.79	3.51	3.91
	Std. Deviation	0.994	1.020	1.000	1.122	1.109

1 = it doesn't matter; 2 = it can be solved at some level; 3 = it is not a problem in our institution; 4 = it should be one of the first priorities; 5 = it is the highest priority.

Table 5. *Correlations*: Role of professors and ICT infrastructure.

Spearman's Rho		The Benefits of the Use of LMS Are Not Fully Explored by Professors	Depends on Teaching Strategies Chosen by Professor	Depends on Professors' Attitude to Them	Professors Are Not Aware of All the Possibilities of ICT	Professors Should Be Trained to Use ICT in the Teaching Process	Depends on the Availability of Infrastructure and the Devices	There Is Not Enough ICT Available in the Educational Environment	There Is No Infrastructure to Use the Technology—i.e., No Wi-Fi, No Smartphones, No Tablets, etc.
The benefits of the use of LMS are not fully explored by professors	Correlation Coefficient	1.000	0.114	0.108	0.167 *	0.211 *	−0.111	0.026	−0.090
	Sig. (2-tailed)		0.179	0.202	0.048	0.012	0.191	0.761	0.292
Depends on teaching strategies chosen by professor	Correlation Coefficient		1.000	0.512 **	0.208 *	0.188 *	0.384 **	0.007	−0.046
	Sig. (2-tailed)			0.000	0.013	0.026	0.000	0.938	0.590
Depends on professors' attitude to them	Correlation Coefficient			1.000	0.427 **	0.452 **	0.564 **	0.216 *	0.036
	Sig. (2-tailed)				0.000	0.000	0.000	0.010	0.676
Professors are not aware of all the possibilities of ICT	Correlation Coefficient				1.000	0.363 **	0.263 **	0.292 **	0.057
	Sig. (2-tailed)					0.000	0.002	0.000	0.500
Professors should be trained to use ICT in the teaching process	Correlation Coefficient					1.000	0.196 *	0.259 **	0.067
	Sig. (2-tailed)						0.020	0.002	0.429
Depends on the availability of infrastructure and the devices	Correlation Coefficient						1.000	0.287 **	0.143
	Sig. (2-tailed)							0.001	0.092
There is not enough ICT available in the educational environment	Correlation Coefficient							1.000	0.267 **
	Sig. (2-tailed)								0.001
	Sig. (2-tailed)								

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

Table 6. *Correlations*: Students' involvement in teaching and learning (TEL) and use of ICT.

Spearman's Rho		Promotes Students' Active Engagement in the Process	Fosters Students' Creativity, Independent Thinking and Problem-Solving Skills	Promotes Students' Awareness and Willingness to Look for Additional Information from Other Sources	Use of LMS Fosters Students' Active Engagement in the Teaching and Learning Process	Helps Students to Better Understand the Topic and Be Prepared to Use ICT in Knowledge Construction	Helps to Ensure Active Learning Processes for Students	Depends on Students' Attitude to ICT	Depends on the Age and Ability of Students to Use ICT	Students Get Bored Very Quickly	Students Lack the Necessary Skills to Use ICT-Enhanced Methods of Teaching
Promotes students' active engagement in the process	Correlation Coefficient	1.000	0.638 **	0.563 **	0.469 **	0.316 **	0.432 **	−0.035	0.042	−0.324 **	−0.083
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.686	0.622	0.000	0.330
Fosters students' creativity, independent thinking, and problem-solving skills	Correlation Coefficient		1.000	0.648 **	0.476 **	0.331 **	0.321 **	−0.052	−0.063	−0.251 **	−0.061
	Sig. (2-tailed)			0.000	0.000	0.000	0.000	0.540	0.462	0.003	0.472
Promotes students' awareness and willingness to look for additional information from other sources	Correlation Coefficient			1.000	0.411 **	0.182 *	0.209 *	−0.121	−0.122	−0.192 *	−0.168 *
	Sig. (2-tailed)				0.000	0.032	0.013	0.155	0.152	0.023	0.047
Use of LMS fosters students' active engagement in the teaching and learning process	Correlation Coefficient				1.000	0.187 *	0.116	−0.093	0.024	−0.079	0.066
	Sig. (2-tailed)					0.027	0.171	0.276	0.782	0.351	0.439
Helps students to better understand the topic and be prepared to use ICT in knowledge construction	Correlation Coefficient					1.000	0.699 **	0.379 **	0.214 *	−0.244 **	−0.004
	Sig. (2-tailed)						0.000	0.000	0.011	0.004	0.962
Helps to ensure active learning processes for students	Correlation Coefficient						1.000	0.369 **	0.296 **	−0.266 **	0.001
	Sig. (2-tailed)							0.000	0.000	0.002	0.990
Depends on students' attitude to ICT	Correlation Coefficient							1.000	0.620 **	0.099	0.063
	Sig. (2-tailed)								0.000	0.245	0.461
Depends on the age and ability of students to use ICT	Correlation Coefficient								1.000	0.030	0.124
	Sig. (2-tailed)									0.727	0.143
Students get bored very quickly	Correlation Coefficient									1.000	0.286 **
	Sig. (2-tailed)										0.001

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

Table 7. *Correlations*: Education for sustainability.

Smart Use of Information Technology in the Teaching Process Might Foster the Development of Students' Liberal Worldview, Open-Mindedness, and Respect for Others	Provides Additional Opportunities to Get Access to Knowledge for Disadvantaged Groups	Boosts the Value of Education	May Contribute to the Development of Liberal, Democratic Worldviews and Greater Civic Engagement	The ICT Used in Education Should Be Previously Evaluated from the Perspective of Its Sustainability
1.000	0.383 **	0.310 **	0.308 **	0.130
	0.000	0.000	0.000	0.127
	1.000	0.569 **	0.503 **	0.395 **
		0.000	0.000	0.000
		1.000	0.426 **	0.202 *
			00.000	0.017
			1.000	0.155
				0.068

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

Analyzing the correlation data on the role of professors and HE infrastructure (Table 5), it can be concluded that the statement that whether ICT will be used depends on the teaching strategies chosen by the professor closely correlates with the statements that it depends on professors' attitude to them (0.512) and on the availability of the infrastructure and the devices (0.384). The statement describing the use of ICT in the learning process as dependent on professors' attitude to them closely correlates with the statements that professors are not aware of all the possibilities of ICT (0.427), professors should be trained to use ICT in the teaching process (0.452) and it depends on the availability of infrastructure and the devices (0.564). The statement on the risk in TEL that professors are not aware of all the possibilities of ICT has strong correlation with the statements that professors should be trained to use ICT in the teaching process (0.363), it depends on the availability of the infrastructure and the devices (0.263) and there is not enough ICT available in the educational environment (0.292). The statement describing that professors should be trained to use ICT in the teaching process as a possible solution to reduce problems has strong correlation with the statement that there is not enough ICT available in the educational environment (0.259). In turn, the statement describing the availability of the infrastructure for HE which states that there is not enough ICT available in the educational environment has strong correlation with the statement that there is no infrastructure to use the technology—i.e., no wi-fi, no smartphones, no tablets, etc. (0.267).

The obtained results confirm that the use of ICT is closely related to the attitude of the professors. At the same time, they point to the relationship of this attitude with both professors' training in using ICT and infrastructure, which generally indicates the need to provide support to academic staff in order to ensure sustainable education, where the role of professors is invaluable.

Next, a correlation analysis was conducted for statements about students' ability to participate actively in TEL using different ICT. The results are summarized in Table 6. As a result of the data analysis, it can be concluded that students' participation is of great significance, confirming the effectiveness of the use of ICT.

The statement that ICT promotes students' active engagement in the process of learning has strong correlation with statements that it fosters students' creativity, independent thinking and problem solving skills (0.638), and promotes students' awareness and willingness to look for additional information from other sources (0.563), and that the use of LMS fosters students' active engagement in the teaching and learning process (0.469), helps students to understand better the topic and be prepared to use ICT in knowledge construction (0.316), and helps to ensure active learning processes for students (0.432).

The statement that ICT fosters students' creativity, independent thinking and problem solving skills, besides the previously mentioned correlations, has strong correlation with promoting students' awareness and willingness to look for additional information from other sources (0.648) and the statements that the use of LMS fosters students' active engagement in the teaching and learning process (0.476), and helps students to better understand the topic and be prepared to use ICT in knowledge construction (0.321).

The statement that ICT promotes students' awareness and willingness to look for additional information from other sources correlates with the previously mentioned statements and has strong correlation with the use of LMS fostering students' active engagement in the teaching and learning process (0.411).

The statement that ICT helps students to better understand the topic and be prepared to use them in knowledge construction has some more correlations besides those previously mentioned: These are with the statements that it helps to ensure active learning processes for students (0.699) and depends on students' attitude to it (0.379). This shows the importance of students' attitude.

There are strong mutual correlations between the statement that ICT helps to ensure active learning processes for students and those previously mentioned, as well as with the statements that it depends on students' attitude to ICT (0.369) and depends on the age and ability of students to use it (0.296), confirming that ICT is an accepted tool to support students in active learning processes, but it

depends on their attitude to them. This confirms the need to strengthen the digital competence of all stakeholders in HE.

The statement that the use of LMS fosters students' active engagement in the teaching and learning process has strong correlations, indicates that these systems can be used as a tool to support learning, though previously analyzed data about professors' digital competence shows that their potential is not fully exploited.

The statement characterizing that how students use ICT in the learning process depends on students' attitude to it has strong correlations with helping students to better understand the topic and be prepared to use ICT in knowledge construction (0.379), helping to ensure active learning processes for students (0.369), and that it depends on the age and ability of students to use ICT (0.620).

In contrast, the statement which characterizes students getting bored very quickly as a challenge in the use of ICT has only one strong positive correlation with the statement that students lack the necessary skills to use ICT-enhanced methods of teaching (0.286), but there are strong negative correlations with statements that ICT promotes students' active engagement in the process (−0.324), fosters students' creativity, independent thinking and problem solving skills (−0.251), helps students to better understand the topic and be prepared to use ICT in knowledge construction (−0.244), and helps to ensure active learning processes for students (−0.266). These results confirm that boredom is not a constant factor which influences TEL, but has strong correlation with the digital competence of students.

These correlations confirm the interrelationship between students' digital competence and attitude toward the use of ICT, supporting active participation in the learning process and indicating positive outcomes for TEL, because positive attitude is one of driving forces to ensure that students are ready for the cognitive load to ensure the development of metacognitive processes and it corresponds with students' motivation [55]. Results on correlation between digital competence and boredom indicate the necessity not only to provide a range of ICT in the learning process, but also to support the development of digital competence to ensure that technologies are used meaningfully. This confirms the conclusion expressed by Mancillas and Brusoe [31], that despite the fact that students are assumed to be digital natives, it should not be forgotten that the development of digital competence requires support, and, at the same time, organizational support is needed for professors to support the development of their digital competence. Otherwise, the cycle of problems will be continued, where the study process becomes more technology-enhanced, but these technologies are not used to their best potential, because neither professors nor students will have digital competence developed to the level required to use technologies in the development of new innovations.

For the purpose of analysis in this paper, Holdsworth and Thomas [48], definition of sustainable education was used. Accordingly, sustainable education was seen as consisting of three components, i.e., (i) knowledge gained through the learning process, (ii) the pedagogical knowledge that academic representatives require, and (iii) organizational changes that mean that innovative learning is part of sustainable education. Results confirm that there is an urgent need to strengthen the digital competence of professors to ensure that technologies are used not only as a tool, but also as the learning materials to support students' digital competence, which has strong correlation with their attitude toward learning and supports sustainable education.

As the next step of data analysis, the statements were grouped to correspond with concepts expressed in the 2015 SDGs [10] for education, and correlations among these statements calculated. Results are summarized in Table 7.

Data analysis shows that the statement that smart use of information technology in the teaching process might foster the development of students' liberal worldview, open-mindedness, and respect for others has strong correlations with providing additional opportunities to get access to knowledge for disadvantaged groups (0.383), boosting the value of education (0.310), and perhaps contributing to the development of liberal, democratic worldviews and great civic engagement (0.308). The statement that ICT provides additional opportunities to get access to knowledge for disadvantaged groups, besides

the previously mentioned correlation, has strong correlations with boosting the value of education (0.569), perhaps contributing to the development of liberal, democratic worldviews and great civic engagement (0.503), and the idea that ICT used in education should be previously evaluated from the perspective of its sustainability (0.395). The statement that the use of ICT boosts the value of education also has strong correlations with the statement that it may contribute to the development of liberal, democratic worldviews and great civic engagement (0.426).

The results of correlation analyses lead to the conclusion that the use of technologies in the learning process not only supports students' active engagement, but also supports the development of values, which are important for a sustainable society. The role of sustainable HE in a sustainable society is also highlighted.

Lastly, respondents were asked whether they would prefer 'old style' ICT-free teaching, i.e., teaching involving no PowerPoint, no YouTube, etc. Results (see Table 8) suggests that the majority of respondents prefer ICT-enhanced teaching (N = 117). The fact that five respondents said 'yes' and 12 'would consider that' is suggestive that the use of ICT in teaching and learning is not free of contention. In this context it is useful to reflect on the following statements by some of the survey participants:

Table 8. *Crosstabulation*: Opinion about switching to 'old style' ICT-free teaching—i.e., no PowerPoint, no YouTube etc. Status.

Count					
	Status				Total
	Student	Professor	Administration	Other	
Yes	1	3	0	1	5
I could consider that	4	8	0	0	12
No	24	86	6	1	117
Another answer	0	6	0	0	6
Total	29	103	6	2	140

"I think we should combine ICT with more classical approaches to enhance our teaching"; "On occasion it is good to go technology-free as it fosters creativity"; "Depends on what teaching style you use. New developments regard ICT-free teaching as the new way of teaching and ICT-teaching as the old style. Point is that ICT can help you in your teaching style, but it's not a teaching style itself. It's not a goal, it's can be something to help you reach a goal"; "The class needs to be well blended. Technology on its own does not ensure effective teaching/learning process"; "It depends on the school level".

Overall, it is plausible to argue that the majority of respondents does not wish to switch back to a technology-free learning environment. Still, the rationale behind the preference to work in technology-free environments requires further research. That is, it should be further analyzed whether this opinion is influenced by the need to support development of other competencies outside the technological environment, or whether such an opinion is based on a negative attitude toward technologies deriving from a low level of digital competence.

5. Discussion and Conclusions

The bold findings of our study as linked to the Research model presented in Figure 1 are as follows. Further analysis is summarized next:

Key Finding 1. Stakeholders are aware of technology enhanced learning solutions. A lot has to be done towards increasing their competence to exploit TEL

Key Finding 2. TEL seems to be understood as a value carrier for Education. Not to the extend to be perceived as a catalyst. Still the human factor remains the dominant

Key Finding 3. Perceived value of TEL in Education is moderate. Stakeholders recognize its value, but they have not reached a level of maximum actualization

Key Finding 4. A number or key requirements, limit the potential of TEL in Education including limited resources, limited computer literacy of TEL, as well as various psychological factors. This for sure needs further analysis and a focused qualitative study on this matter is under development.

Key Finding 5. The Sustainable Education model recognizes the key contribution of Human Factor and Technology factor in a balanced way with emphasis to be paid in the sharing of common perceptions and value models.

Key Finding 6. The connectivity of education and sustainability, is supported by responders' opinion. A resource based view of Education is promoting a strategic Sustainability model. The key issue that needs further investigation is which are the determinants of measurable sustainable goals in Education linked with the other aspects of Sustainability: Economy, Society, Environment

Beyond these general qualitative findings, a number of complementary aspects are provided below:

Analysis of the results confirms that use of technologies in the learning process promotes students' active participation. The analysis allows us to conclude that technologies, if used meaningfully, support sustainable education, but there are also critical points, which should be taken into account.

Firstly, students' digital competence influences their attitude toward ICT use. Boredom during the study process is influenced by a low level of digital competence and indicates the need to support the development of students' digital competence, but this is a hard task if professors' digital competence is not developed.

Results show that most respondents indicate that infrastructural problems hinder their use of ICT in the learning process. At a time when Higher Education institutions are looking for technological solutions that support students in the learning process, but are at the same time looking for possibilities to reduce expenditures, it is important to bear in mind all aspects which can influence the sustainability of education during the process of transformation.

Results show an emerging necessity to support professors in the development of their digital competence as it is already indicated in the research carried out by Claire Englund, Anders D. Olofsson and Linda Price [56] who states that supporting conceptual change should, therefore, be a central component of professional development activities if a more effective use of educational technology is to be achieved. The support should be provided in consideration of other problems, such as workload, pedagogical competence in use of ICT, and the development of predictive analytical competence to take pedagogically correct decisions on the use of ICT without previous knowledge about their use [17]. Another aspect which is called "pedagogical inertia" should be taken in mind to find the solutions to overcame it [56].

Although positive outcomes of ICT use are acknowledged, and it can be seen that sustainable education can be provided [48], more attention should be paid to civic engagement and support for disadvantaged groups in order to achieve the SDGs [10].

More challenges of TEL are focused on professors' digital competence and the infrastructure of HE (see Table 5). Such risks as students' undeveloped competence to use ICT and boredom in the study process have a low level of influence; however, it should be borne in mind that providing students with different ICT, which they do not have the necessary skills can lead to boredom and negative attitude (see Table 6).

Correlation calculations on statements which characterize sustainability from the perspective of SDGs allows us to conclude that the use of ICT in the learning process to support TEL can support achievement of the SDGs. However, these results should be taken together with other results, like problems with professors' digital competence, ICT infrastructure, and students' ability to interact with ICT.

To support sustainable development of the society, more effort should be focused on the development of digital competence across the society: Otherwise, competent use of technologies is associated with ICT experts, but other parts of society have a low level of digital competence [43]. The need to improve digital competence across the society indicates that there are still insufficient ICT experts, but many of duties expected to be performed by them can be done by everyone if digital competence is developed at a higher level.

The main conclusion is that there is an urgent need to support the development of stakeholders' digital competence to ensure sustainable HE, which is great challenge in the transformative processes of HE systems all around the world. It is necessary to acknowledge that technologies can reduce the need for human and financial resources; however, it should be understood that putting a huge amount of effort into the development of technologies will see a weak outcome if no corresponding effort is put into human resource development to support people's digital competency. As Amador et al. [50,57] concluded in their research that staff development and organizational changes are needed to support Sustainable education.

Given that this is the first cycle of ongoing research, there are limitations, which should be acknowledged. Firstly, this study does not test the outcomes of educational initiatives; the sample is also small (N = 140), and the groups of respondents represent different countries, HE status and scientific areas that do not allow comparison to be made between the groups.

It should be acknowledged that the opinions gathered from HE stakeholders and presented here are from the internal HE perspective. Opinions are therefore gathered from a group of people with access to HE and they may not be assumed to be the opinions of the whole society.

Future research directions should shed light on sustainable HE not only from the perspective of learning outcomes, use of ICT, development of ground for new innovations, and so on, but also from the perspective of barriers caused by HE itself. For example, what factors lead to drop-out from HE? Why is there still gender imbalance in several fields and how to overcome these problems? The question of how sustainable HE can support education for sustainability should also be kept in focus.

In the long term, the evolution of Sustainable Education, must be seen as an integral part of a long term Smart Cities strategy, and the deployment of technologies and technology enhanced learning solutions should be considered as a value carrier for engaged citizenship [58–61].

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